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Advanced Integrated Multi-sensor Surveillance (AIMS)

Operator Machine Interface (OMI) Definition Study

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Contract Number: W7711-4-7904/01-TOR

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Human Systems Integration Section, DRDC Toronto

Contract Report
DRDC Atlantic CR 2006-242
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Canada

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Contract Report

DRDC Atlantic CR 2006-242

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Abstract

To increase the capability of searching, detecting, classifying, and identifying contacts particularly at night and in poor weather, the Advanced Integrated Multi-sensor Surveillance (AIMS) system is being developed. The AIMS system is advanced through the integration of five sensors with active gated capability into a single gimbal. As such, the system will support a myriad of missions for both the CP-140 and Fixed Wing Search and Rescue (FWSAR) communities including timely search and rescue (SAR) response and ground surveillance in aid of the Land Forces (LF). To ensure optimal performance the AIMS system requires an appropriate interface and controls, the design of which must realize the interaction between technological capability and operator performance. This document, prepared by CAE Professional Services on behalf of Defence Research and Development Canada, presents preliminary design concepts and associated rationale for the AIMS Operator Machine Interface (OMI). The intent is to provide a framework for the future evolution of the AIMS OMI as well as identify areas for investigation.

Résumé

Afin d'augmenter la capacité de recherche, de détection, de classification et d'identification de contacts, en particulier la nuit et par mauvais temps, un système intégré perfectionné de surveillance multi-capteurs (AIMS) est en cours de développement. Ce système est perfectionné par l'intégration de cinq capteurs à capacité de déclenchement actif en un cardan unique. Il pourra ainsi servir à une multitude de missions de CP-140 et de FWSAR (aéronefs à voilure fixe pour la recherche et sauvetage), entre autres pour des interventions rapides de recherche et de sauvetage et la surveillance au sol à l'appui des forces terrestres (FT). L'efficacité optimale du système AIMS nécessite une interface et des commandes appropriées, dont la conception doit assurer l'interaction entre la capacité technologique et les performances des opérateurs. Le présent document, rédigé par CAE Professional Services pour RDDC Canada, présente les principes de conception préliminaires de l'interface opérateur-machine (IOM) et les justifications connexes. Il vise à fournir un cadre pour l'évolution future de l'IOM du système AIMS et à identifier des domaines d'étude.

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Executive summary

Introduction

To increase the capability of searching, detecting, classifying, and identifying contacts particularly at night and in poor weather, the Advanced Integrated Multi-sensor Surveillance (AIMS) system is being developed by Defence Research and Development Canada. The AIMS system integrates up to five sensors, including thermal imaging and active gated capability, into a single gimbal. As such, the system is capable of supporting the CP-140 and Fixed Wing Search and Rescue (FWSAR) communities by improving search and rescue (SAR) response and ground surveillance in aid of the Land Forces (LF). To ensure optimal performance the AIMS system requires an appropriate interface and controls, the design of which must realize the interaction between technological capability and operator performance. This document presents preliminary design concepts and rationale for the AIMS Operator Machine Interface (OMI). The OMI includes the suite of controls and displays that comprise the AIMS console for the effective operation of the AIMS sensor package. The intent of this document is to provide a framework for the future evolution of the AIMS OMI as well as to identify areas for future investigation.

Results

The OMI concepts are built upon an analysis of tasks related to the employment of the AIMS system on the Fixed Wing Search and Rescue (FWSAR) and maritime CP-140 platforms to support the conduct of SAR and ground surveillance missions respectively. The task information coupled with standard human factors engineering OMI guidelines and requirements as well as lessons learned from predecessor systems (i.e. the Airborne Laser Based Enhanced Detection and Observation System (ALBEDO) and the Enhanced Low-light Level Visible and Infrared Surveillance System (ELVISS)) were used to develop the preliminary OMI design concepts presented in this report. The predominant goals in designing the OMI included:

a. providing quick access to all the basic controls/functions;

b. improving system usability through automation;

c. providing strong situational awareness cues;

d. providing clear feedback of all user actions; and

e. utilizing natural, intuitive interface styles, cues and responses.

A complete description of the AIMS system is provided in the report.

Significance

Throughout the development of the task information and OMI concepts, operational subject matter experts from both the CP-140 and FWSAR communities were consulted. As such, input from military experts served to shape the OMI concept design. Of particular benefit were the lessons learned that were gathered from members of the 14 Wing who had flight experience with the Wescam MX-20 sensor system as part of the Aurora Incremental Modernization Program. The results from this report will serve as an aid to understanding functionality associated with sensor surveillance systems and as a guide toward the design of effective human to system interfaces in any military environment where optical imaging systems are employed.

Future Plans

The intent of this work is to provide an initial framework for the continued evolution of the AIMS OMI and therefore a number of human factors issues for the AIMS system have been introduced that require further research and evaluation. Areas of further study include investigating the implications to the design of the console of applying mosaic imaging to the system, and similarly automatic scan mode; considering some of the distinct functionality of the current MX20 operation in the design; and investigating design issues for a console that would support multiple operators.

The results from this report will feed into the design of a hardware prototype OMI during the system integration phase of the AIMS TDP. Thus, system engineers will use this report as a guide in the design of an optimal interface for AIMS.

Baker, K. and Youngson, G. 2006. Advanced Integrated Multi-sensor Surveillance (AIMS) Operator Machine Interface (OMI) Definition Study. DRDC Atlantic CR 2006-242. Defence R&D Canada - Atlantic.

Sommaire

Introduction

Afin d'augmenter la capacité de recherche, de détection, de classification et d'identification de contacts, en particulier la nuit et par mauvais temps, un système intégré perfectionné de surveillance multi-capteurs (AIMS) est en cours de développement. Ce système intègre en un cardan unique jusqu'à cinq capteurs, y compris des capacités de déclenchement actif et d'imagerie thermique. Il peut ainsi servir à une multitude de missions de CP-140 et de FWSAR (aéronefs à voilure fixe pour la recherche et sauvetage) en améliorant les opérations de recherche et sauvetage (SAR) et la surveillance au sol à l'appui des forces terrestres (FT). L'efficacité optimale du système AIMS nécessite une interface et des commandes appropriées, dont la conception doit assurer l'interaction entre la capacité technologique et les performances des opérateurs. Nous présentons ici les principes de conception préliminaires de l'interface opérateur-machine (IOM), et les justifications connexes. L'IOM comprend la suite de commandes et d'affichages de la console AIMS, permettant l'exploitation efficace de l'ensemble de capteurs AIMS. Le présent document vise à fournir un cadre pour l'évolution future de l'IOM du système AIMS et à identifier des domaines d'étude futurs.

Résultats

Les principes de l'IOM se fondent sur une analyse des tâches liées à l'utilisation du système AIMS à bord de FWSAR et de plates-formes maritimes CP-140 aux fins de missions SAR et de surveillance au sol, respectivement. Pour élaborer les principes de conception préliminaires de l'IOM présentés ici, on a utilisé l'information sur les tâches de même que les lignes directrices et exigences ergonomiques standard pour les IOM, en mettant à profit les leçons tirées de l'expérience de systèmes antérieurs (Système laser aéroporté perfectionné de détection et d'observation (ALBEDO) et Système perfectionné de surveillance à intensification de lumière visible et à infrarouge (ELVISS)). La conception de l'IOM visait principalement les objectifs suivants :

a. assurer un accès rapide à toutes les commandes et fonctions de base;

b. améliorer la convivialité du système par l'automatisation;

c. fournir des indices de grande valeur pour la connaissance de la situation;

d. assurer une rétroaction claire pour toutes les actions des utilisateurs;

e. exploiter des indices, des réponses et des styles d'interface naturels et intuitifs.

Le rapport présente une description complète du système AIMS.

Portée

Afin d’élaborer l’information sur les tâches et les principes de l’IOM, on a consulté des experts des opérations des appareils CP-140 et FWSAR. L’information fournie par les experts militaires a contribué à définir la conception de l’IOM. La contribution de membres de la 14e Escadre, qui avaient fait l’expérience en vol du système de capteurs Wescam MX-20 dans le cadre du Programme de modernisation progressive de l'Aurora, s’est avérée particulièrement utile. Les résultats présentés ici permettront de mieux comprendre le fonctionnement des systèmes de surveillance à capteurs et serviront de guide en vue de la conception d’interfaces hommes-machines efficaces dans tout environnement militaire où sont utilisés des systèmes d’imagerie optique.

Recherches futures

Le présent document vise à fournir un cadre initial pour l’évolution de l’IOM du système AIMS. Il présente donc un certain nombre de facteurs ergonomiques applicables à ce système, qui exigent des recherches et une évaluation plus approfondies. Les domaines à étudier ultérieurement comprennent les implications de l’application de l’imagerie mosaïque et du mode de balayage automatique pour la conception de la console; la prise en compte de certaines fonctions distinctes du système MX20 actuel dans la conception; et les questions de conception d’une console utilisable par plusieurs opérateurs.

Les résultats présentés ici serviront à la conception d’un prototype d’IOM matérielle lors de la phase d’intégration système du PDT AIMS. Les ingénieurs système pourront ainsi utiliser le présent rapport comme guide en vue de la conception d’une interface optimale pour l’AIMS.

Baker, K. and Youngson, G. 2006. Advanced Integrated Multi-sensor Surveillance (AIMS) Operator Machine Interface (OMI) Definition Study. DRDC Atlantic CR 2006-242. Defence R&D Canada - Atlantic.

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1. Introduction

1.1 Background

To increase the capability of searching, detecting, classifying, and identifying contacts particularly at night and in poor weather, the Advanced Integrated Multi-sensor Surveillance (AIMS) system is being developed. Earlier versions of AIMS were the Airborne Laser Based Enhanced Detection and Observation System (ALBEDOS), and the Enhanced Low-Light Level Visible and InfraRed Surveillance System (ELVISS). The AIMS system is advanced through the integration of five sensors with active gated capability into a single gimbal. As such, the system will support a myriad of missions for both the CP-140 and FWSAR communities including timely search and rescue (SAR) response and ground surveillance in aid of the Land Forces (LF). To ensure optimal performance the AIMS system requires an appropriate interface and controls, the design of which must realize the interaction between technological capability and operator performance.

CAE Professional Services (formerly Greenley and Associates Inc.) has been contracted to provide human factors research and development support in the development, design, and evaluation of operator interface concepts for controlling the AIMS system.

1.2 Objective

The objective of this document is to present preliminary design concepts and associated rationale for the AIMS Operator Machine Interface (OMI). The intent is to provide a framework for the future evolution of the AIMS OMI as well as identify areas for investigation.

1.3 This Document

This section outlines the background and states the objectives of this report. The report outline in this section is intended to show the relationship between the other sections and to guide the reader in finding sections of interest within the document. In addition are the following sections:

a. Section Two describes the AIMS system to provide context for subsequent sections regarding the AIMS OMI design.

b. Section Three presents the tasks analysis results from the AIMS Mission, Function, and Task Analysis in the form of task groupings which translate into design requirements for the AIMS system.

c. Section Four outlines the design approach and subject matter expert (SME) assessments completed to date.

d. Section Five documents the design concepts for the AIMS console. In addition to outlining the overall design, each of the major display and control components (e.g. moving map display and controls) are discussed in detail.

e. Section Six details the design rationale influencing the overall AIMS design as well as its components.

f. Section Seven articulates several areas of exploration to support the continued evolvement of the AIMS OMI.

g. Section Eight provides a list of pertinent resources used in the generation of this document.

h. Annex A maps each of the tasks listed in Section Three to the AIMS functionality that supports its implementation.

2. AIMS System Description

2.1 General

This section is intended to provide a high-level overview of the proposed AIMS system in order to provide context to the subsequent OMI design and rationale.

NOTE: Since the creation of this report, the AIMS system configuration has changed—the colour camera WFOV has been substituted with a laser rangefinder. The following system description reflects the AIMS system configuration at the time of writing this report (i.e. no laser rangefinder). The OMI design concepts in subsequent sections of this report are also aligned with this original configuration.

2.2 AIMS Characteristics

In accordance with the AIMS TDP Requirements Specification [Reference 12], the AIMS system will provide the following operational characteristics:

a. Enhanced target discrimination and localization in surveillance and tactical environments using integrated active imaging, thermal sensing, mapping and optimized search algorithms.

b. State of the art automatic target detection and recognition, image processing and target tracking that reduce crew workload and stress, while improving target detection and recognition in SAR, surveillance and target designation missions.

c. Increased knowledge on metadata, data management and information dissemination requirements in a network-enabled environment such as C4ISR.

d. Integrated information display, optimized on human factors considerations.

e. Improved search methodologies through sensor modeling in a new mission planning tool.

2.3 AIMS Components

Figure 1 depicts the air and ground segments that comprise the AIMS system. The focus of the OMI effort articulated in this report is the controls and displays that comprise the Operator Station. This workstation provides the primary interface to the AIMS sensor package containing the imaging sensors which are used to search, detect, classify, identify, and track objects of interest. The AIMS system is based on a modified Wescam MX-20 turret and will be comprised of the following five imaging sensors:

a. Infrared (IR) thermal imager (mid-wave IR);

b. Electro Optic (EO) Narrow Field of View (NFOV) (visible; near-IR);

c. Active Gated Television (AGTV) NFOV;

d. AGTV Wide Field of View (WFOV); and

e. Colour camera WFOV.[1]

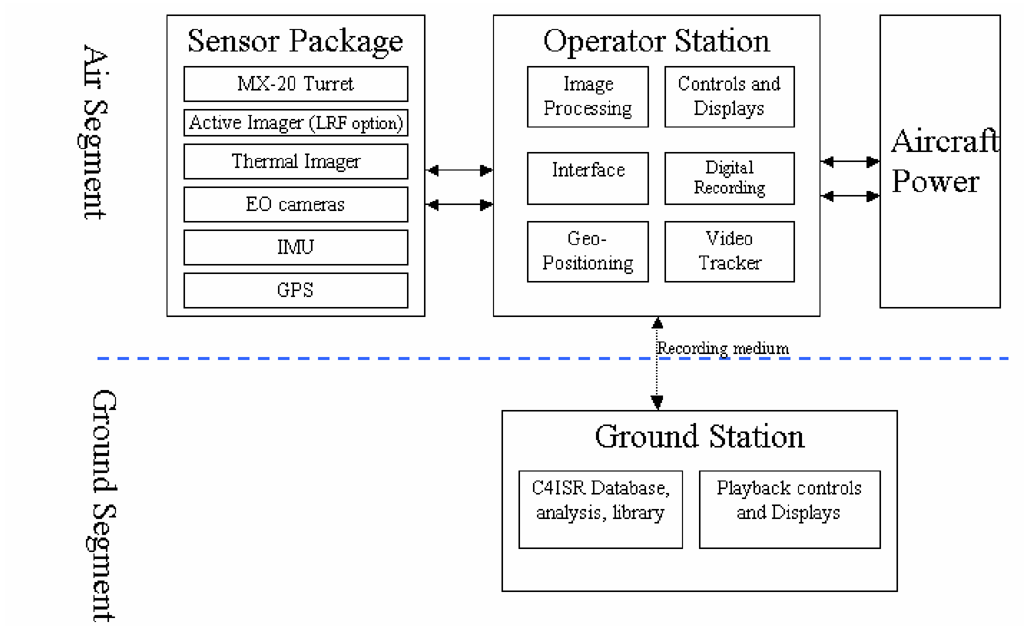

Figure 1. *AIMS System Integration*

2.3.1 IR Thermal Imager

The IR thermal imaging sensor being used as part of the AIMS system operates in the mid-wave range of the spectrum. Four discrete FOV options (18.2°, 3.7°, 0.73°, and 0.24°) are available and selectable with an electronic zoom capability. The optical focal lengths vary from 40 mm (WFOV) to 1500 mm (VNFOV). Accordingly, the aperture diameter will change from 8.6 mm to 215 mm. The minimum resolvable temperature difference is less than 0.25K at a spatial frequency of 23.6 cycles/mrad and less than 0.5K at 36 cycles/mrad. Polarity of the thermal imager can be varied between white hot and black hot.

[1] As noted earlier, this imaging sensor has since been replaced with a laser rangefinder.

2.3.2 EO NFOV

The EO NFOV imaging sensor is a single Charge Coupled Device (CCD) colour (½") camera for providing colour imagery in daytime situations. (A CCD is an imaging sensor comprised of an array of linked, or coupled, capacitors. The light-sensitive capacitors can hold a charge corresponding to variable shades of light.). FOV settings are selectable from 4 discrete options (0.49°, 0.24°, 0.15°, and 0.092°). For all focal lengths, the aperture diameter will remain 180 mm. Automatic and manual modes of operations are provided for the focus and gain/level controls.

2.3.3 Active Imager

The active imager is comprised of two main components the laser illuminator and cameras (AGTV NFOV and AGTV WFOV).

The laser illuminator is a DALIS™ laser diode array at 800nm (± 5nm) with the temperature stabilized to 3.0°C. The pulse rate can be varied between 15 to 60 KHz while remaining synchronized with the image intensifier's gain (range gating). The laser pulse rise time is between 100 and 150 ns with a fall time of 40 ns. For operation at a maximum of 10km, the maximum rate (to remove ambiguity) is 15 KHz (66 µs between each pulse) with a maximum gate width of 6.6 µs (10% duty cycle).

The active imager cameras combine a ½" CCD camera and an equivalent Gen 3 Intensifier Tube. The AGTV NFOV will possess the same FOV settings as the EO NFOV sensor (0.49°, 0.24°, 0.15°, and 0.092°), whereas a continuous zoom capability will be provided with the AGTV WFOV. The gate width is variable from 100 ms to 6.66 µs and slaved to the laser pulse width. The gate position is adjustable anywhere from 20 m to 15 km. A continuous mode of operation (i.e. no range gating) is also available.

2.3.4 Colour Camera WFOV

The EO WFOV imaging sensor is a triple CCD colour ($^1/_3$") camera with low to medium magnification imagery. Unlike the EO NFOV, a continuous zoom capability is provided as opposed to discrete settings. Automatic and manual modes of operations are provided for the focus and gain/level controls.

2.3.5 Wescam MX-20 Sensor Turret

The AIMS sensors will be housed in the Wescam MX-20 sensor turret (Figure 2). The steering range is 360° continuous rotation for the azimuth and +90° to -120° for the elevation. The steering slew rates will vary from 0 to 57.3°/s. The modes of operation include rate, position, geo-pointing (sub mode of rate and geo), Autoscan, Step-Stare (Strip and Spot), Forward and Stow.

Figure 2. *Wescam MX-20 Sensor Turret*

3. Operator Tasks

3.1 General

The task analysis results provide the framework for creating the AIMS OMI. Individually these tasks represent operational requirements for the AIMS OMI. As such, the OMI must allow the operator to execute these tasks in order to support higher level mission requirements. The AIMS tasks as presented and subsequently analyzed in this report have been adapted from the original ALBEDOS and ELVISS analyses [References 17 and 19].

3.2 AIMS Task Groupings

As in Reference 17, the AIMS tasks were grouped both functionally and by mission phase, as there are important design considerations which emerge from both viewpoints. The task groupings are as follows:

a. pre- and post-flight tasks;

b. AGTV control tasks;

c. camera and lens control tasks;

d. steering control tasks;

e. monitor and management tasks;

f. pre-search tasks;

g. search tasks;

h. detection tasks;

i. tracking tasks;

j. classification and identification tasks;

k. rescue site evaluation tasks; and

l. return transit tasks.

Depending on the mission, certain task groupings may not be relevant. For example, the CP-140 conducting a route survey in support of the LF may not be required to evaluate a rescue site (task grouping 11).

For each grouping of tasks, a brief description of the operator tasks is presented, operational problems are described, and interface design considerations to alleviate the problems are identified.

3.2.1 Pre- and Post-Flight Tasks

The pre- and post-flight tasks encompass safely starting the equipment, confirming and adjusting settings for the mission, confirming proper operation of subsystems, and safely shutting down the equipment.

For instance, a Non-Uniformity Correction (NUC) must be conducted on the IR camera prior to starting a mission. Since each element (or pixel) of the infrared detector array has a slightly different responsivity, a correction factor for each of these elements is required in order to acquire a uniform image in intensity when looking at a scene having a uniform temperature. To obtain these correction factors, the operator enters into the NUC mode of the camera and inspects a plate of uniform temperature that is placed in front of the lens. For the AIMS system, a one-point correction NUC is performed with a single plate at a given temperature.[2]

Identified Operational Problems

The pre- and post-flight tasks are generally conducted in a low-demand situation where the operator has sufficient time to thoroughly complete the tasks in a sequential checklist fashion while other aircraft startup and shutdown activities are in progress. The most critical tasks are verifying that the desired switch settings are made and conducting the functional checks of the system. Failure to select correct switch settings could result in reduced system performance during the mission, while failure to complete functional checks correctly may lead to undetected system failures which could render the system unserviceable for the mission.

Interface Design Considerations

Confirmation of switch settings should be simplified by grouping controls according to function and sequence of use. Where possible, system parameters should default to the “most likely” setting on initial power-up. Abnormal conditions should be highlighted according to their significance. Pre- and post-flight operator checklists should be available. Alerts should be displayed on startup for critical functional checks until the check is completed or the alert is acknowledged. Automatic system checks (built-in test) should be incorporated where possible.

The operator requires access to the NUC mode for the IR camera in order to perform the necessary correction prior to commencing the mission. The NUC

[2] A two-point correction NUC requires two plates at different temperatures.

can be done automatically once power is applied to the system. For instance, ELVISS rotated the sensor table inside the gimbal to look at the inside wall of that gimbal which should be at a uniform temperature.

3.2.2 AGTV Control Tasks

AGTV control tasks address all aspects related to the control of the laser illuminator and the associated electronics that synchronize the operation of the laser with the low-light level TV (LLLTV) cameras. Tasks include arming and activating the laser, choosing the AGTV mode of operation (gated or continuous), selecting the divergence of the laser beam, adjusting the gate range (automatically or manually), controlling the gate depth, as well as setting the power level, pulse width, and repetition rate of the laser. The operator must also be aware of the illuminator status, divergence, gate range, and gate depth at all times when using the system.

Identified Operational Problems

The laser illuminator is not completely eye-safe, requiring a safe viewing distance. Precautions are therefore required to prevent inadvertent activation as well as provide sufficient notification to the operator to potentially hazardous situations. In addition, arming the laser will typically be carried out in conjunction with the search; therefore, this control must be readily accessible to the operator while maintaining visual attention to the screen.

During the airborne ALBEDOS trials, operators had difficulties optimizing gate range and depth parameters for the search task. The cause could be attributed to a combination of the design of the controls as well as the difficulty in determining the optimum settings for these parameters. An inaccurate gate range results in a loss of sight of the target. The effect of an inaccurate gate depth is more subtle. In good weather conditions, an excessively large gate depth will have little effect on the display image since there are too few obscuring particles to cause any significant deterioration. In poor weather conditions, an excessively large gate depth may cause loss of sight of the target even though it is within the gate depth, because the light reflected from the obscuring particles is enough to mask the target.

During ground tests with the ELVISS hardware prototype, the pulse width setting was adjusted in conjunction with changes to the beam divergence. As such, an optimum pulse width is associated with each beam divergence; however, this relationship is not readily apparent to the operator. In addition, changes to the beam divergence may be carried out during a search and therefore adjustments must be possible without requiring visual aid.

In many situations in which the image quality was deteriorating it was difficult for the ALBEDOS operator to determine which of the parameters affecting image quality required adjustment. Digital on-screen readouts of illuminator range, gate depth, focus, and pulse width were provided. Given time, this information might have been sufficient for an operator to puzzle through the situation and determine what adjustments should be made to improve the image. Unfortunately, the required time was not available, and so operators were reduced to a trial and error approach. On top of this, the controls were haphazardly located so that once the operator had decided on the parameter to adjust, it was necessary to divert attention completely away from the displayed image to find the desired control. No guidance was available to determine what would be an appropriate gate depth for a given situation. No simple means was provided to correlate the illuminator range to the focal length of the camera. During both the ALBEDOS and ELVISS field trials, operators also tended to focus on the image while not maximizing the use of the available capabilities of the system.

Interface Design Considerations

Due to safety implications, a guarded switch should be provided for arming the laser to prevent inadvertent activation. The laser should always arm in the passive mode only, and should be inhibited from arming with the active mode selected. If an attempt to arm the laser is made with active mode selected, an operator alert should appear.

The operator must be able to adjust the laser illuminator parameters while continuing to monitor the image presented from the camera. Functioning of range and gate depth controls should be possible simultaneously with panning and tilting actions. Continuous feedback of illuminator range and gate depth in relation to camera focal distance is required. An indication of preferred gate depth for various environmental conditions should be provided. The laser illuminator gate range should be automatically adjusted based on the range to the target as provided by terrain data.[3] Moreover, including an automatic range mode would allow the gate range to vary in unison with changes in aircraft altitude, terrain height, and sensor bearing. In the automatic mode, the operator may be reserved to making fine adjustments to the range value.

Finally, since an optimum pulse width is associated with each beam divergence, controls should be integrated for adjustment of these two parameters or assistance provided to maximize the correlation between the two settings.

[3] A laser rangefinder could also be employed to provide range data in support of adjusting the range gate. During the creation of this report, the AIMS system did not employ a laser rangefinder; therefore, this option was not investigated in further detail.

3.2.3 Camera and Lens Control Tasks

Camera and lens control tasks address all aspects of the control of the five cameras. For all cameras, these tasks include controlling the settings (as applicable) to the focus (automatic or manual), Field-Of-View (FOV)/zoom, electronic zoom, filter, infrared (IR) polarity (IR camera only), iris, and gain. The operator must also be aware of the status of these parameters at all times when using the system.

Identified Operational Problems

For every camera, the most critical control tasks are those associated with adjusting focus, FOV/zoom, and gain. The need to adjust the focus is based on the sharpness of the image. Typically, a focus setting at infinity is satisfactory unless the FOV/zoom function is used. When the image is zoomed, the focus control is generally required to optimize the image. The operator uses the FOV/zoom functions after an object of interest is detected and needs to be further classified and/or identified. When zooming, pan and tilt adjustments are typically required to keep the image centered in the viewing area. Bringing an object of interest to the centre of the display and keeping the object of interest in the viewing area when zooming are high gain tasks. During the ELVISS field trials, operators found it arduous to simultaneously control where the sensor was looking and adjust the zoom. Specifically, difficulties arose maintaining the target of interest centered in the field of view while zooming in. The operators also found it painstaking to progressively zoom out in order to resume a search.

During the original ALBEDOS trials, the management of three different image quality controls for the CCD camera proved operationally ineffective, specifically gain, level, and iris settings. For the operator, there were three different controls which were essentially trying to achieve the same objective, while operating on different parts of the sensor control panel. A high degree of training would be required to understand how to use these camera controls effectively, and the time required to adjust the controls would invariably have an adverse effect on other control tasks.

For the IR camera, the use of the averaging and mapping functions, as well as the gain and level controls is also expected to be difficult for the intended operator (a SAR Tech rather than an experienced sensor operator). Here also extensive training would be needed to prepare the operator to use the full range of IR controls effectively.

As noted in the ALBEDOS HEDAD-O [Reference 19], it would be difficult for a SAR Tech to master the full capabilities of the AGTV system. The incorporation of an additional sensor into the ELVISS system has a compounding effect which increases the complexity of the system and its operation. This issue may be further exacerbated with the proposed inclusion of five sensors in the AIMS system. Every opportunity needs to be taken to simplify the operation of AIMS system for the intended users through means such as automation and effective OMI design.

Interface Design Considerations

The operator must be able to adjust the focus, zoom/FOV, and the gain in conjunction with monitoring the incoming imagery and conducting panning and tilting actions. For each camera, continuous feedback of these three settings is required by the operator. Automatic modes should be the norm for control of focus and gain with manual reversionary or “fine-tuning” modes also available. However, the gain control has an effective automatic setting which should be used as the default operating mode. Access to the manual gain and level controls is therefore not as important as access to zoom and focus. A rapid zoom out function would help to alleviate the difficulties associated with zooming out in order to resume a search. Due to the interdependency between the FOV/zoom and focus settings, these controls should be located adjacent to one another to allow the operator to switch from one to the other without diverting visual attention from the display. Other low-level controls should be set up with default values which the AIMS operator does not have to worry about. Even the selection of polarity can represent an unnecessary complexity for the infrequent operator.

A means to designate a position (or object) on the display screen and automatically bring that position to centre screen could relieve the operator of the high gain, pan and tilt control requirements for aiming the AIMS system at detected objects, thereby significantly improving the identification process for targets. A trackball controlling a cursor would be an effective way to implement this feature. The possibility of automatically adjusting to maximum zoom when this function is activated could also be investigated.

Even with the emphasis on simplification, it is important to retain the full operational capability of the five sensor systems. This may be accomplished by placing the primary controls (i.e. most important and frequently used) in the most favourable position for ease of use.[4] Secondary controls not normally needed for basic camera control would be “hidden”. This approach to the OMI design supports the occasional use of the AIMS system by experienced sensor operators for test flights, evaluations and special purpose missions.

3.2.4 Steering Control Tasks

Steering control tasks include selecting the system mode (manual, mosaic, scan), configuring mosaic mode parameters, pan and tilt controls for the

[4] Within the CP-140, the zoom rotary knob for the Wescam MX-20 is located approximately head high to the left of the operator. Operators expressed displeasure with its location given the frequency with which the control has to be accessed during normal operation.

AIMS stabilized platform, adjustments to the pan and tilt sensitivity, slewing the turret to a pre-determined position, and controlling automatic scanning modes.

Identified Operational Problems

Steering control tasks while in manual mode require continuous or near continuous activation of the pan and tilt controls. Steering controls must provide rapid slew rates to permit the operator to respond to verbal commands quickly, and also fine adjustment to permit the operator to keep an object steady in the FOV, particularly when the image is magnified through the zoom feature.

The operator may receive steering information from other crewmembers in relation to aircraft axes (i.e. “10 o’clock, close”). The operator must be aware of where the camera is pointing in relation to the aircraft in order to respond to this situation. Similarly, the operator may need to pass information on a contact using the same reference frame.

Image movement will occur as a result of both aircraft movement and camera movement. The operator needs to know where the camera is pointing in order to resolve the components of image movement attributable to each.

The FOV for the AIMS cameras and laser illuminator are relatively small. To use this device as a search aid, the operator must therefore have precise control of the camera direction, in addition to knowing the path over the ground that the camera must take. The operator must be able to track the area already scanned by the AIMS system in order to carry out an efficient search. Otherwise, the search will invariably be somewhat random and ineffective. Even if the operator knows the desired path of the AIMS camera over the ground, exercising manual control of the camera to achieve the desired result is a difficult, high workload task, particularly for an extended period of time. Given the attentional demand required of the operator for the search task, it is unreasonable to expect the operator to be able to simultaneously manipulate the camera in a precisely controlled path.

The mosaic mode is an advanced feature introduced by the AIMS Technology Demonstration Program (TDP) as a proposed solution to assist with utilizing the AIMS system as a wide area search tool. Feedback from CP-140 SMEs within the Maritime Proving and Evaluation Unit (MP&EU) at Canadian Forces Base (CFB) Greenwood, Nova Scotia stressed difficulties conducting searches with the proposed Wescam MX-20. The smaller field of view afforded by the system (as compared to the field of view for the “naked” eye) gives the impression of conducting a search through a ‘straw’. To alleviate this constraint, the mosaic mode introduces the ability to automatically sweep a pre-determined pattern using a narrow field of view to produce a series of high resolution, NFOV images which are then aligned to form a single high resolution wide field of view image. The operator will view each image sequentially as the aircraft proceeds along its search pattern, moving to the next region only when satisfied that there are no potential targets in the region of interest.

Configuring the AIMS system for mosaic mode is dependent on a series of interrelated parameters such as aircraft data (course, altitude and speed), camera angle, as well the desired overlap, FOV, and resolution. Configuration of the mosaic mode parameters will typically be performed during transit to the area of responsibility in preparation for the search. Although, the setup of the 'optimum' mosaic mode may prove to be challenging for the AIMS operator. Furthermore, these parameters may be needed to be re-configured in real-time during a search.

Interface Design Considerations

Pan and tilt controls for the manual slewing of the AIMS system should be implemented such that the operator can man them continuously while still accomplishing all other required tasks. Once pointed at an object, regardless of zoom setting, it must be easy for the operator to keep the object in the desired position on screen. To that end, an automatic tracking function must be easily activated at this point.

Determining the 'optimum' parameters for configuring the mosaic mode given the mission conditions is not always a straightforward process. This task may become more difficult during a search when the operator's attentional demand must be focused on the task at hand. To that end, the system should provide recommended settings to assist the operator with easily configuring the mosaic mode.

In the ELVISS report [Reference 17], it was recommended that the operator should be seated facing forward in the helicopter if possible to avoid any confusion over direction when receiving instructions from another crewmember. The primary AIMS operators within the Aurora, Non-Acoustic Sensor Operator-1 (NASO-1) and NASO-2, are not seated facing forward but this should not pose a problem given the extensive experience these operators have employing sensors. On the FWSAR, the proposed location of the Navigator/Sensor (Nav/Senso) station is facing forward. Two Dimensional (2-D) visual presentations of camera position in relation to the aircraft should be presented with aircraft heading "up" on the display to avoid any confusion with directions.

The operator must be provided with a simple, intuitive display of camera position in relation to the aircraft axes. The display of camera position in relation to the aircraft axes must permit the operator to resolve the approximate contributions of camera controls and aircraft movement to overall image movement.

Regardless of the system mode (mosaic, manual, or scan), a record of area scanned as well as an indication of search quality must be provided to the operator. To assist with managing the overall search, the area that has been reviewed by the imagery analyst while in mosaic mode should also be provided. A trace on a moving map display could be used to accomplish both of these objectives. Automatic scan pattern options should be provided to the operator to assist in achieving consistent, thorough coverage of a search area, and to reduce operator fatigue from the repetitive steering control tasks.

3.2.5 Monitor and Management Tasks

The monitor and management tasks are those associated with ensuring that the system continues to function effectively throughout the mission. The main conditions to be monitored by the operator are platform drift, laser status, display status, and recording media status.

Identified Operational Problems

Platform drift may occur if the electrical nulls for the pan, tilt and zoom controls wander. The most likely manifestation of this condition is a small slew rate being continuously present in the platform pan, tilt, or zoom (or a combination). The operator may detect the condition depending on the other factors contributing to image scrolling. The operational problem caused by this condition is increased difficulty in tracking a contact. This in turn will lead to a more difficult identification task. The operator must be able to detect and rectify this condition.

The operator must be continuously aware of the status of the laser illuminator from the perspective of the "eye safety range" when radiating to ensure that the illuminator is not presenting a hazard to individuals on the ground. In addition, the operator must be cognizant of a potential malfunction leading to an over-temperature condition.

Regardless of the type of display selected for the AIMS system, the operator should be able to control characteristics normally subject to adjustment such as brightness, contrast and picture position.

The demands on the operator to control the video recording system should be minimized. For the AIMS system, it is anticipated that the video recording will be initiated at the start of the mission and continue for the entire mission. The screen capture feature will typically be used when the operator has achieved the best possible image of a contact. While the AIMS operator will want to view a screen capture, ground station personnel may also be responsible for further evaluation of imagery. The final operator action in this process is likely to be a pan/tilt input or a cursor movement and "slew-to-cursor" command. The screen capture control should be operable without requiring the operator to divert attention from the screen and should be co-located with the main image manipulation controls (i.e. pan/tilt and cursor control device).

Interface Design Considerations

If possible, platform drift should be nulled automatically. If this is not possible, a momentary Autonull switch which eliminates drift in all axes should be provided. This relates primarily to the pan and tilt functions and should be co-located with these controls.

Arming of the laser illuminator should be protected by a guarded switch unless a completely eye-safe laser illuminator is used. A continuous alert should be provided when the laser illuminator is active. A discrete alert should be provided in the event of a laser over-temperature condition.

Normal display adjustment controls should be appropriate for the type of display used.

Video recording controls should be centrally located for operation by either hand, and follow standard conventions for control. A continuous alert should be provided when recording is in progress. There should be no requirement to change tape during a mission.

The screen capture should be a momentary switch conveniently located for operation in conjunction with either the pan and tilt controls or the cursor control device. The operator should have the capability to quickly send classified and unclassified e-mails with screen captures or video clips to desired recipients.

3.2.6 Pre-Search Tasks

Pre-search tasks include determining the predicted weather for the search area and subsequent evaluation of the expected sensor performance. The search object identification features are determined and the search area terrain is reviewed. A search plan is established and briefed. The AIMS operator confirms the system serviceability and ensures the equipment is correctly configured.

Identified Operational Problems

The pre-search tasks have a high cognitive and decision-making content which will directly influence the conduct of the search. The evaluation of expected sensor performance is based on the environmental conditions, operator knowledge and experience with the sensor. AIMS performance in various environmental conditions should be documented and available to the operator for this evaluation. To confirm system serviceability the operator must review the status of each AIMS component. An on-screen “system status" readout of all verifiable components would functionally group this information and allow the operator to quickly determine overall system serviceability.

Interface Design Considerations

A manual of AIMS performance and preferred system settings for various environmental conditions (e.g. overcast, rain), terrain (e.g. over water, mountainous), and mission type (e.g. SAR, tactical surveillance) should be available to the operator. Since the operator may wish to review this information while search operations are underway, a hard copy manual will be more effective than an on-screen presentation.

System status for all verifiable components should be presented as a group. This information should be displayed only on operator request.

3.2.7 Search Tasks

Search tasks include determination of the actual weather for the search area and subsequent evaluation of the actual sensor performance. The operator continuously monitors one or multiple camera images to detect possible search objects, and may slew the stabilized platform based on visual contacts or reports of possible contacts from other operators. The operator may initiate or terminate an automatic scan pattern (mosaic or auto scan modes) for the AIMS system as well as the auto-cueing function that focus the attention of human analysts to specific objects of interest within the incoming imagery. The operator maintains a record of the sensor coverage of the search area, and maintains a general situational awareness of the nature of the terrain in the vicinity and the general search progress.

Identified Operational Problems

Monitoring the sensor image for possible contacts is a high demand continuous task. The contrast between the search object and background varies, but in many cases the search object is difficult to detect. Humans tire and become bored quickly when engaged in tasks of this nature, with an associated decrease in detection performance. Ideally, an automatic cueing or detection algorithm should be implemented to assist the operator. It is considered unlikely, however, that an effective auto-detection algorithm could be developed, in part because of the low signal-to-noise ratio of many targets, and in part due to the high number of false detections which might be expected. In the meantime, operators should be relieved from the task frequently, limiting continuous search time to approximately 15 minutes, within the constraints of crew availability. A possible approach to sharing the search time might be to transmit the incoming video image via a high bandwidth wireless data transmission system directly to a ground station for analysis. If this approach were deemed to be operationally effective, it is assumed that the data would be transmitted continuously, and that there would be no associated operator tasks during the search, detection, tracking and identification phases of the mission.

The availability of five cameras gives the operator multiple sensor video images to monitor. It is expected that in most situations one sensor will be relied upon heavily, due to the current sensor performance and/or the characteristics of the search object. For instance, conducting a search at night with low cloud cover would suggest using a camera with active gated capabilities. In other instances, the camera selection may not be definitive in the operator's mind. As such, the AIMS operator may require help to determine the 'optimum' camera selection.

Since each sensor works in different frequency spectrums (i.e. IR vs. visible) and offers different versions of the real-world, their detection performance will often be different just as the video representation of targets will be different. Range is also a factor in that IR cameras usually offer the better detection range; however, AGTV may provide a better detection range if a retro-reflective object (e.g. binoculars, eye glasses, and retro-reflective patches on a life jacket) is illuminated by the AGTV laser illuminator. Once it had been determined which sensor is more likely to "see" the search object in the current conditions, the operator would consider that sensor as primary for the current activity. Peripheral vision would then be relied on along with occasional scans of the secondary sensor windows to check for contacts in the other sensor images, although, this proves increasingly problematic for the AIMS system which contains 5 incoming images. The operator will have to keep track of which sensor is primary in order to manage any controls which are common to all sensors. For example, auto-tracking is available on all sensors, and the operator will have to designate which one to use and then maintain awareness of which one is active.

Slewing the camera to investigate contacts will generally mean that a systematic search pattern must be interrupted. The operator must know where the pattern was interrupted in order to restart the coverage in the correct location on the next pass. The decision to divert the camera from a planned pattern will require a snap judgment call by the operator; however, the interruption can be minimized if a trace of the AIMS footprint is continuously maintained and plotted for the operator to view.

Interviews with SMEs from MP&EU with flight experience using a Wescam MX-20 stated that the system is not conducive to conducting wide area searches.[5] This type of search must be conducted with none or limited prior knowledge/intelligence regarding the location of the search object. For instance, a ship lost at sea may be localized depending on its last sighting and

[5] As part of the on-going Aurora Incremental Modernization Program (AIMP), the CP-140 is being fitted with a Wescam MX-20. MP&EU personnel are responsible for flight testing the proposed EO/IR system.

expected drift patterns. The inability to effectively conduct a wide area search is caused in part by two factors:

a. The limited field of view provided by the system at a high zoom factor makes it difficult (or impossible) to search for a specific object while maintaining situational awareness (SA) with respect to the current area of focus within the larger search area; and

b. The speed at which the CP-140 travels (approximately 200 KIAS) makes it onerous to conduct a progressive search. The aircraft travels faster than operator's ability to search a given area with the Wescam MX-20; therefore, the crew is forced to circle back and resume the search from the last spot. The operators experienced difficulties resuming the search from the last spot that they looked at.

The terrain encountered during searches may vary widely. Different search techniques may be more appropriate for different conditions. For planning purposes, it should be possible for the operator to anticipate the upcoming terrain in order to plan the optimal search strategy.

Interface Design Considerations

The OMI must make it clearly apparent which sensor is currently the primary. This is important for SA and efficient management of the sensor suite. Although most of the sensor controls work independently of the primary selection, select controls (like auto-tracking) are dependent on the primary sensor designation. Also, the control used for designating the primary sensor must be designed for quick access.

The OMI must provide the ability for the AIMS operator to compare incoming imagery from the individual cameras in order to ensure the 'best' camera has been selected for conducting the search. This could involve providing sensor thumbnails to allow the operator to continuously observe the imagery from all cameras to ascertain the picture quality. In addition, the control for designating the primary sensor must allow a thumbnail to be quickly selected as necessary for display as the primary sensor window.

Alerts generated by the auto-cueing function need to be displayed to the operator so that they gain the operator's visual attention. Additional cueing mechanisms, such as auditory alerts, could be implemented to further support this function. Although, care must be taken to ensure that the auto-cueing function does not generate a significant number of 'false positives' thereby reducing its perceived value to the operator.

If the AIMS system is to be employed as a tool for wide area searches by the CP-140 crew, the system must provide the ability to conduct a progressive search at a sufficient resolution. This may be accommodated by an automated sweep that stitches together a series of high resolution, NFOV images to form a single high resolution WFOV image as proposed by the mosaic mode.

Throughout the mission the operator should have constant access to visual images of the upcoming terrain, as well as to the terrain which has already been searched.

3.2.8 Detection Tasks

Detection tasks include the sighting on the display of a possible search object, the initiation and termination of video recording, the determination and reporting of contact position, and the possible initiation of a contact information file.

Identified Operational Problems

In some conditions, the detection tasks may be done using other sensors (e.g. radar) or visually whereby the AIMS system is reserved to supporting the classification and identification of the contact. In these instances, the AIMS operator will need to quickly slew the system to a contact detected by a different sensor or to a specific location provided by another operator.

The determination of contact position involves slewing the AIMS system until the contact is in the centre of the image such that the system range and bearing are relative to the contact, and not another point on the image. The task of manually slewing while using both pan and tilt controls simultaneously proved difficult during the original ALBEDOS trials, particularly when the zoom function was in use. Fine control of the camera pan and tilt might be improved if the operator was able to use a cursor control device to place a cursor over the target on the display, and then use a “slew-to-cursor” function to bring the contact position to the centre of the display.

The report of contact position may be required in several different forms. Within the crew, the information required is usually the relative position of the contact to the aircraft and slant range. Therefore contact positions are generally passed as a clock position and measure of distance. If there is a distinct ground feature in the vicinity of the contact, the position of the contact may be passed in relation to the ground feature. The AIMS operator must as a minimum be supplied with sufficient information to easily determine and report contact position in relation to the aircraft. This requires an indication of the direction in which the AIMS system is pointing, and the horizontal range at which the contact is detected.

Contact information passed external to the aircraft is usually based on a geographic reference, or possibly with reference to a fixed navigation aid such as a Very High Frequency (VHF) Omni Range (VOR) site.[6] It is not anticipated that the AIMS operator will be involved in direct communications with external agencies, and therefore has no real need for geographic coordinates. If this information were reserved to the AIMS operator, it would be necessary to verbally pass the contact coordinates to another operator, who would record them manually, and then transmit them over the radio. The verbal transmission of number strings is prone to error. A readout of contact latitude and longitude on the AIMS display, while feasible, is not recommended. It is preferable that all navigation issues be addressed by the flight deck crew, and that verbally passed position information be limited to contact bearing and range using standard terminology. Once the pilots receive the contact relative bearing and range from the aircraft, they can use the data to establish a waypoint in the navigation system which can then be converted to a latitude and longitude. The optimal method would be to preclude the requirement for position to be passed verbally. Establishing an electronic link between the aircraft navigation system and the AIMS system would make it possible for the AIMS operator to designate the contact, and have a waypoint appear directly in the aircraft navigation system display in the cockpit. The crew will still use verbal conning to communicate internally, but a possible source of error in the storage of contact position information will have been removed.

Interface Design Considerations

A “slew-to-cursor” feature should be considered to ease the task of centering a contact in the display as opposed to relying on manually slewing the AIMS system with pan and tilt controls.

The AIMS operator requires contact position information relative to the aircraft axes. The AIMS operator should be able to designate a contact and automatically pass position information to the aircraft navigation system.

Communications with external agencies typically relay contact position as a geographic reference. The radio operator (pilot) requires contact position as a latitude and longitude. The aircraft navigation system should complete a conversion from relative bearing and distance to latitude and longitude.

The incorporation of data from multiple sensors into the AIMS display would facilitate the process of correlating data from multiple sensors. For instance, the inclusions of radar contacts on the digital moving map would allow the AIMS operator to select the contact from this display and automatically slew the AIMS system to the radar contact.

[6] To support interoperability with the LF, horizontal range values to a location of interest may also be required by the CP-140 crew. Similarly, the FWSAR aircraft may utilize a horizontal range when coordinating a SAR mission with ground resources.

3.2.9 Tracking Tasks

Tracking tasks include the maintenance of a target in the camera FOV manually, the initiation of automatic tracking, the monitoring and manual adjustment of automatic tracking, and reporting the status of the tracking task.

Identified Operational Problems

Tracking a contact manually is a high demand continuous task. During the ALBEDOS trials, tracking contacts proved to be challenging, particularly at close range and when using the zoom feature of the camera. While operators tracked contacts, other controls (range, depth, focus, zoom, gain) associated with image quality were under-utilized due to task saturation. Even with auto-tracking, there is a continuous workload to monitor the accuracy of the tracker and to provide manual adjustments to the tracked position.

With all sensors being capable of performing the auto-track function, the operator will have to determine which one to use. Only one can be active at a time because all cameras are resident within the turret and must move together. Based on current sensor performance and the quality of the contact images, the operator will decide which sensor to use for auto-tracking. If not already designated, that sensor must be selected as primary before auto-tracking is activated. Other factors affecting the sensor decision include the types of auto-tracking available on each sensor as these options may vary from one sensor to another. Geographic position tracking is likely to be independent of the sensor (requiring only navigation-related data) and therefore should be available for all sensors.

While monitoring the auto-tracker performance, the operator may decide to change the type of tracking and/or the sensor doing the tracking. As the contact image changes due to relative motion, changing weather and/or lighting effects, the performance of the currently selected tracker may be degraded and an alternate tracker may be needed. The operator will require training to understand the abilities of the available trackers with respect to image quality and contact characteristics.

Interface Design Considerations

Automated tracking options include edge, contrast, correlation, and geographic position/scene (AUTO-POINT) tracking. The OMI should simplify the management of auto-tracking as much as possible. Quick access is needed to initiate and deactivate auto-tracking with a given sensor. Default tracking options should be provided wherever appropriate. The sensor being used and the type of auto-tracker should be readily apparent to the operator.

3.2.10 Classification/Identification Tasks

The classification and identification tasks include the monitoring and optimization of the contact image, and attempts to determine the precise nature of the contact. Identification may be limited to confirming that the contact is not the search object. The location of the contact may be marked for future reference, particularly if the identification cannot be achieved. Comments on the nature of the stored contact may be required. The outcome of the identification is reported to other crewmembers.

The AIMS system provides five cameras and associated sensor video images which can be used to classify and identify the contact. The complementary frequency spectrum coverage can simplify and aid the classification process for a trained operator by increasing the available information about the contact. The choice of sensor for identification will typically be dependent on environmental factors. In addition, each sensor provides different capabilities in order to support these tasks. For instance, the AGTV relies on reflected light which tends to pick out the finer shape and size characteristics. As such, it can be used to read large lettering on an aircraft or a boat, which may be invisible in the IR image.

Identified Operational Problems

The identification of an object may require that the aircraft be re-positioned to obtain a more advantageous view of the contact. The AIMS operator will normally provide verbal instructions to the pilot to bring the aircraft to the desired position. The operator must be able to rapidly determine the direction in which the pilot should turn, which requires knowledge of the search object location in relation to the aircraft.

Different cameras may tend to highlight different characteristics of the contact. Therefore the operator may want to study multiple sensor images as the classification is being made. The operator may need to switch quickly back and forth between multiple sensors to obtain the ‘best’ picture.

The operator may wish to record notes about a particular contact. Currently, notes are made by hand on a scratch pad during a search, since no other method is readily available. This method is effective for the occasional, brief notes required, and a preference was stated by SAR operators to continue to use this “low tech” method with the AIMS system to avoid complicating the operator interface unnecessarily.

Interface Design Considerations

Having the operator seated facing forward in the aircraft would help alleviate any confusion over direction when passing instructions to the pilot. 2-D visual presentations of camera position in relation to the aircraft should be presented with aircraft heading “up” on the display to avoid any confusion with directions. However, this may not always be an option when installing the AIMS system within a given aircraft.

The ability to quickly switch between which sensors are designated as primary (or secondary) is critical if the OMI design give visual priority to a subset of sensor windows as opposed to simultaneously displaying imagery from all five sensors.

The inclusion of functionality to record notes about contacts electronically within the AIMS system would be beneficial; however, this may only be feasible for a two-person operation. This could be coupled with the ability to quickly send an e-mail with contact snapshots and meta data to a pre-defined list of recipients (e.g. SAR supporting agencies such as a Joint Rescue Coordination Center).

3.2.11 Rescue Site Evaluation Tasks

The rescue site evaluation tasks include the determination of the nature of the terrain at the rescue site and an assessment of the associated hazards for conducting a personnel or equipment drop. It is assumed that the pilots are equipped with aided-vision systems which permit them to view the rescue site, and that the evaluation is a cooperative effort with the pilots assuming responsibility for hazards to the aircraft, and the AIMS operator assessing the hazards to the personnel that will be inserted into the rescue site. The AIMS operator maintains overall awareness of the operational situation, and reports significant observations with respect to the rescue site. In addition, the AIMS operator will monitor the equipment/personnel drop with the system. Discussions as to the method of insertion, the best site for the insertion, and the planned sequence of events will generally be conducted between the crewmembers.

Identified Operational Problems

This task sequence will generally exercise all aspects of the AIMS operator interface, however no new operational problems are introduced that have not already been discussed in previous paragraphs.

Interface Design Considerations

No new interface design considerations associated with the rescue site evaluation have been identified.

3.2.12 Return Transit Tasks

The return transit tasks include the conduct of off-task checks and collection of data for post-mission analysis. The tasks are largely concerned with returning the equipment to the required pre-shutdown configuration and ensuring that images and video required for post-flight analysis are safely stored.

Identified Operational Problems

The return transit tasks are generally conducted in a low-demand situation where the operator has sufficient time to thoroughly complete the tasks in a sequential checklist fashion while the aircraft transit is in progress. There are no critical tasks during this mission phase.

Interface Design Considerations

An off-task operator checklist should be available. The checklist will be relatively simple and should not be included in the OMI.

4. OMI Methodology

4.1 General

The design and development of the AIMS interface and its interactive style are based upon a standard design approach and a series of consultations with Subject Matter Experts (SMEs). The SME consultations were primarily managed through formal meetings. The combination of these two considerations is essential to the creation of an OMI that satisfies the mission objectives of the operational community.

4.2 OMI Design Approach

The generation of the AIMS OMI design was executed on the basis of two key strategies:

a. **Iterations.** OMI design is not a waterfall process. Rather it follows a tri-partite cycle or spirals. Design consists of repeating the three primary sub-activities of design-prototype-evaluate where the output of the preceding stage is fed into the next stage. For instance, evaluating an interface uncovers design weaknesses or introduces new ideas to augment the design. Either way, what has been learned through the evaluative process is re-worked into the original design to create a new iteration of the design. The design is then re-prototyped and re-tested to assess the design changes. This cycle continues throughout the design process until satisfactory results are obtained

b. **User-centered design (UCD).** The OMI design is based upon a user's abilities and needs, context, work, goals, and tasks. Consequently, a fundamental tenant of interface design is that end-users should play an integral role in the entire design process. UCD is based on understanding the domain of work or play in which people are engaged and in which they interact with computers. In addition, it requires focusing on the product's potential users from the very beginning, and checking at each step of the way with these end-users to be sure that the design meets the users' need and that the users are comfortable with the final design.

4.3 AIMS Meeting Process

In addition to the application of accepted interface design principles to the AIMS OMI design, a series of meetings were conducted with AIMS stakeholders and SMEs to evolve the design. SME involvement is critical since this community provides an understanding of the operator's mental model as well as ensures that mission-related factors capable of affecting the design are not overlooked.

To date SME feedback has been gathered via heuristic assessment of the AIMS interface. While this is beneficial, next generations of the AIMS OMI design require assessments to be completed in a task-based manner whereby measures are captured to evaluate the impact of the proposed design on factors such as usability, task performance, and workload. Operators would informally rate their perceived ease of use and perceived utility assessments of the presented system, which will form the backbone of usability assessments that will guide design decisions.

5. Preliminary AIMS OMI Design

5.1 Overall Console Design

Figure 3 depicts a notional design for the overall console for the AIMS system for a single operator[7]. The primary control and display elements that comprise the AIMS console are described in greater details in their respective sections.

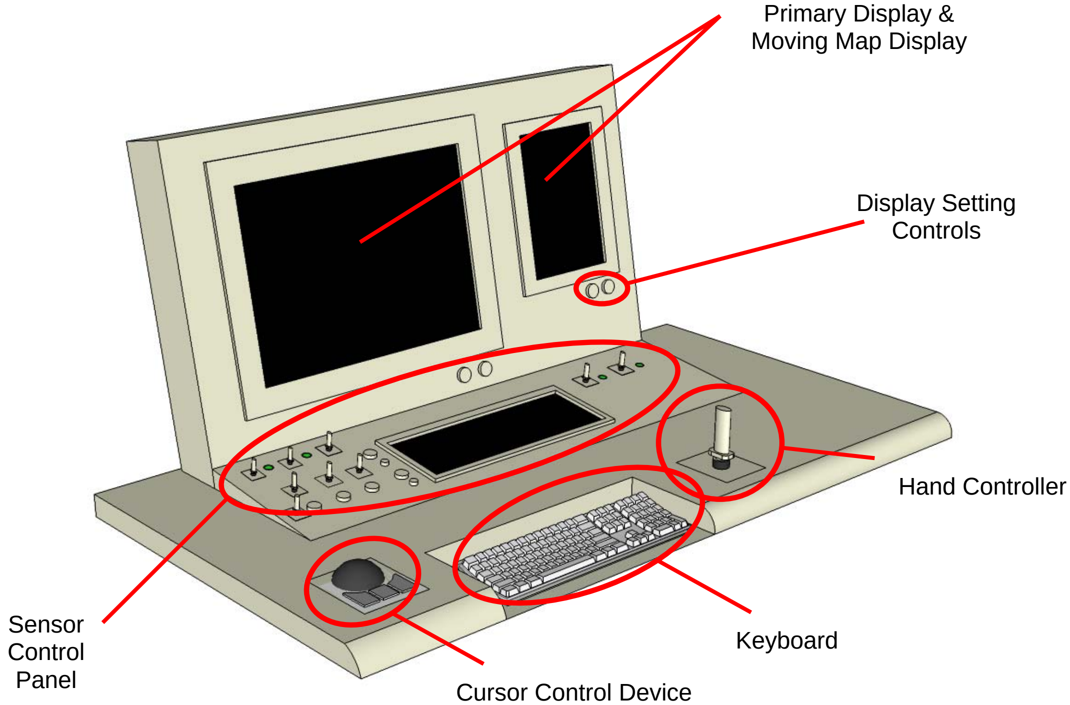

Figure 3. *AIMS Console Design – Single Operator*

If one operator is to be solely responsible for operation and monitoring of the AIMS system, responsibilities would include analyzing the raw incoming imagery, manipulating the sensor parameters, managing the conduct of the search, and maintaining situational awareness. The simultaneous execution of these activities may introduce a high workload. In addition, vigilance may become a problem with relying on a single operator to continually monitor incoming imagery for contacts. Both of these conditions may in turn pose a detriment to the quality of the mission

[7] This figure is intended to represent the overall layout of the AIMS console and not the exact design or configuration of each control and display element.

performance. Task sharing with a secondary operator may alleviate these potential problems; however, crew availability may negate this solution.

Despite these issues, discussions with CP-140 SMEs at the MP&EU (CFB Greenwood) indicated a preference for the AIMS system to be operable by a single crewmember, ideally NASO-2. In this configuration, the AIMS display(s) would be located within the operator's primary field of view. Similarly, controls would be easily accessible from the primary seated position. Preliminary assumptions by the SMEs indicate that utilization of the AIMS system (or similar EO/IR system) by one operator may be compatible with missions over water. Typically in these situations, the crew compiles a radar plot to detect contacts and the EO/IR system would be reserved to classification and identification of radar contacts. As such, demanding search tasks would not rely on utilizing the EO/IR system. However, missions over land, especially the conduct of searches, are more complex whereby it is anticipated that the EO/IR system will play a larger role with the detection of contacts, in addition to assisting with the classification and identification activities. To that end, the conduct of overland missions may be more effectively executed if two operators jointly utilize the EO/IR system. In this configuration, the following two operators are envisioned:

a. **Payload operator.** The payload operator would manage the search as well as control the sensor. On the Aurora, this responsibility would be delegated to the NASO-1.

b. **Imagery analyst.** The imagery analyst would study the raw imagery to conduct the detection, classification, and identification functions. The NASO-2 on the Aurora would be responsible for this activity.

In the FWSAR aircraft, it is anticipated that the primary operator of the AIMS system would be the Nav/Senso. In contrast to the CP-140 crew whereby each NASO is a dedicated sensor operator, the FWSAR Nav/Senso will have additional responsibilities to monitoring and managing the EO/IR system. With a two-person configuration for select SAR missions, the Flight Engineer would support the employment of the AIMS system on the FWSAR.

To that end, the AIMS system needs to be configurable to support the division of labour between two operators in support of the conduct of certain missions. Similarly, the system configuration must allow the operators to swap displays without moving from their seated position in order to facilitate a reversal of roles. Figure 4 illustrates a notional console design for two operators. The design encompasses the same fundamental control and display elements as found in the single console design. AIMS design concepts presented in this report will focus on a single operator. Issues surrounding the design of a two-operator console for the AIMS system are introduced in Section 7.

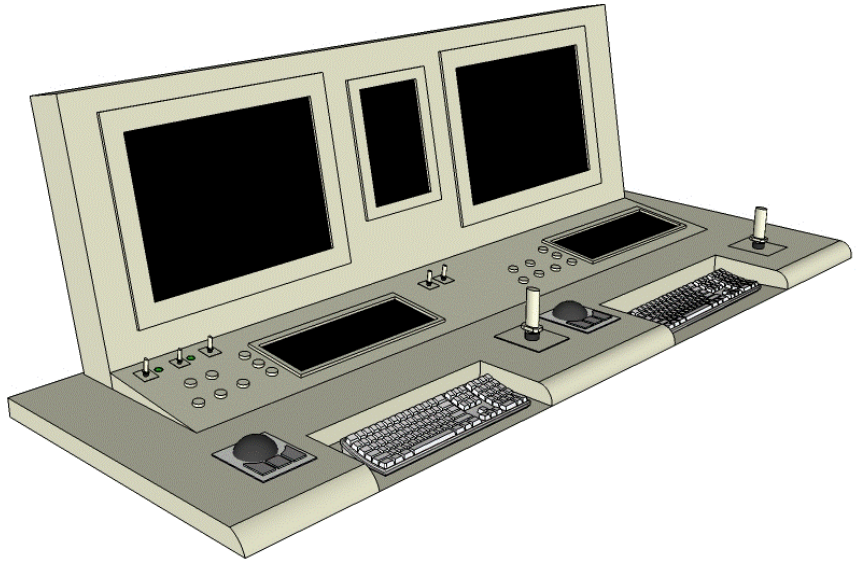

Figure 4. *AIMS Console Design – Two Operators*

5.2 Primary and Moving Map Displays

Both the ALBEDOS and ELVISS designs were comprised of a single display. Based on the expectation of a single operator interacting with the system, the display monitor for ELVISS was assumed to be a single 17” diagonal flat panel with expected resolution of 1024 by 768. By adding an IR sensor to ELVISS, the original ALBEDOS design was revised to make room for a second sensor window so that the operator would possess the capability to view both the IR and the AGTV sensors simultaneously. This is considered essential when the operator is searching for an object which may exhibit thermal properties and/or reflective properties. Two options (even split vs. uneven split) were considered for the incorporation of the second sensor window [Reference 17]. For both options, the moving map display area remained unchanged from the ALBEDOS design.

The proposed console design for the AIMS system includes two displays. The larger screen herein referred to as the primary AIMS display, would be a 21” diagonal flat panel with expected resolution of 1600 by 1200 in order to view incoming imagery from the sensor and control its operation (Figure 5). A monitor of this size is still economically feasible. A larger monitor and/or higher resolution could be used thus providing more flexibility in the OMI design.

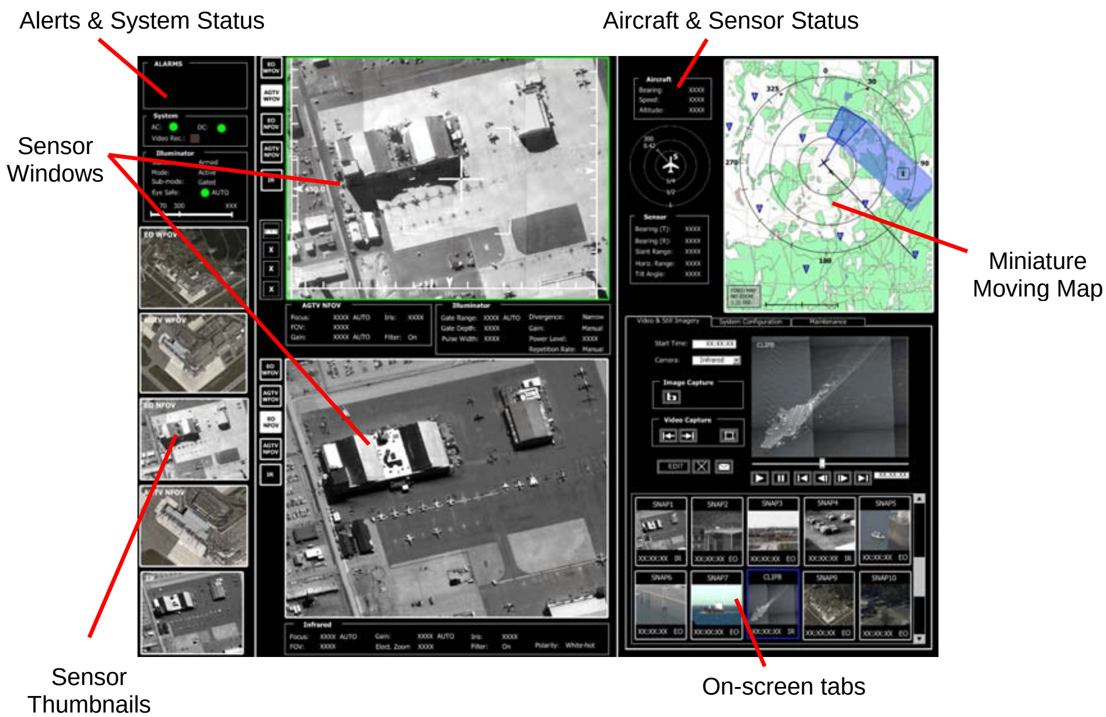

Figure 5. *Primary AIMS Display – Manual/Auto Scan Modes*

Prominent groupings of functionality that will encompass a significant portion of the real estate on the primary AIMS display include:

a. **Sensor windows.** Raw imagery being fed from the camera(s) will be displayed in the sensor windows for viewing in real-time. The source to be displayed is configurable by the operator in order to provide flexibility depending on the operational requirements. Status information will be presented as a combination of overlays on the imagery as well as text fields adjacent to the sensor window. Refer to Section 5.2.1 for details.

b. **Aircraft and Sensor Status.** Presents pertinent data regarding the aircraft and sensor status. Included is a polar plot which provides a quick visual reference providing relative bearing of where the camera is pointing and horizontal range to the object specified by reticule. Refer to Section 5.2.2 for details.

c. **Sensor thumbnails.** These thumbnails provide a small view from each camera. This provides awareness of the image quality to support selection of the camera for viewing in a larger sensor window. Refer to Section 5.2.3 for details.

d. **On-Screen Tabs.** Secondary controls are reserved for this area since they are neither frequently used nor control critical functionality. As such, this functionality does not need to be constantly visible or accessible to the operator. Functionality includes configuring the layout of the primary sensor window, viewing sensor status information, playback and viewing of imagery captured by individual cameras, as well as maintenance-related data. Refer to Section 5.2.4 for details.

e. **Alerts and System Status.** This area is dedicated to presenting system status information and displaying alerts. Refer to Section 5.2.5 for details.

f. **Miniature Moving Map.** A smaller version of the moving map display is presented on the primary display to provide an additional perspective when viewing the raw imagery within the sensor windows. Refer to Section 5.2.6 for details.

A second smaller screen, or Moving Map display, will be employed to present a larger version of the digital moving map (Figure 6). The moving map with overlays provides situational awareness to support higher level functions such as managing the integrity of a search. Further investigation is required to determine the best utilization of the two proposed moving maps.

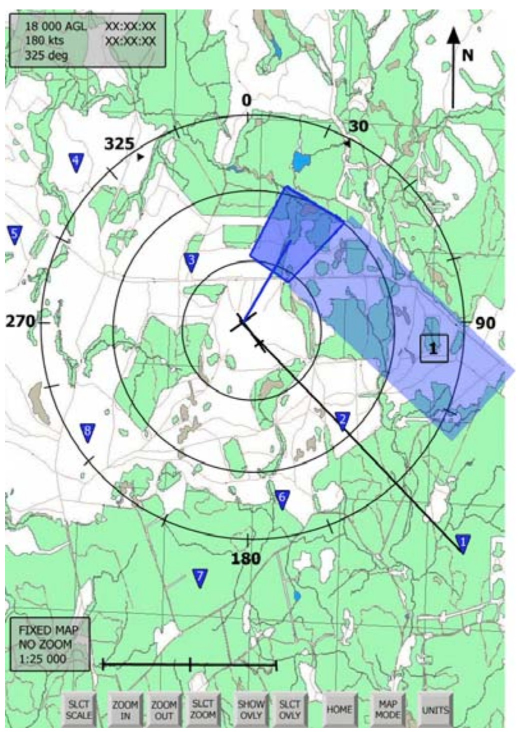

Figure 6. *Digital Moving Map Display*

5.2.1 Sensor Windows

Each sensor window on the primary AIMS display will present the raw imagery from the individual sensors as designated by the AIMS operator. The size of the sensor window is fixed as per Table 1.

Table 1. *AIMS Camera Windows Resolution*

CAMERA	RESOLUTION
Thermal Imager (IR)	640 x 480
EO NFOV	768 x 494
AGTV NFOV	640 x 480
AGTV WFOV	640 x 480
Colour Camera WFOV	768 x 494

Sensor Window Graphical Overlays

The operator may designate one of the sensor windows to be the primary display. This selection should normally be used to indicate which sensor is receiving most of the operator's attention. Selection of the primary sensor has several effects:

a. the primary window is highlighted with a green border;

b. automatic tracking commands are sent to the primary sensor; and

c. the camera footprint display on the moving map matches the current primary sensor.

Figure 7 illustrates graphical overlays for the primary sensor window (in this case the IR camera) to enhance the operator's ability to maintain awareness of the current sensor configuration as well as correlate the imagery with geo-positional data.

The primary sensor window will have the following overlays:

a. **Reticule.** The image reticule marks the centre of the displayed image. As well as represents the geographic position for which range and bearing information is calculated and displayed. The reticule is also used to indicate the current tracking mode (auto vs. manual). A cross-hair reticule indicates that auto-tracking is not engaged. A square bracket reticule denotes auto-tracking is engaged, and the size of the square bracket varies to show the size of the image area which is being tracked.

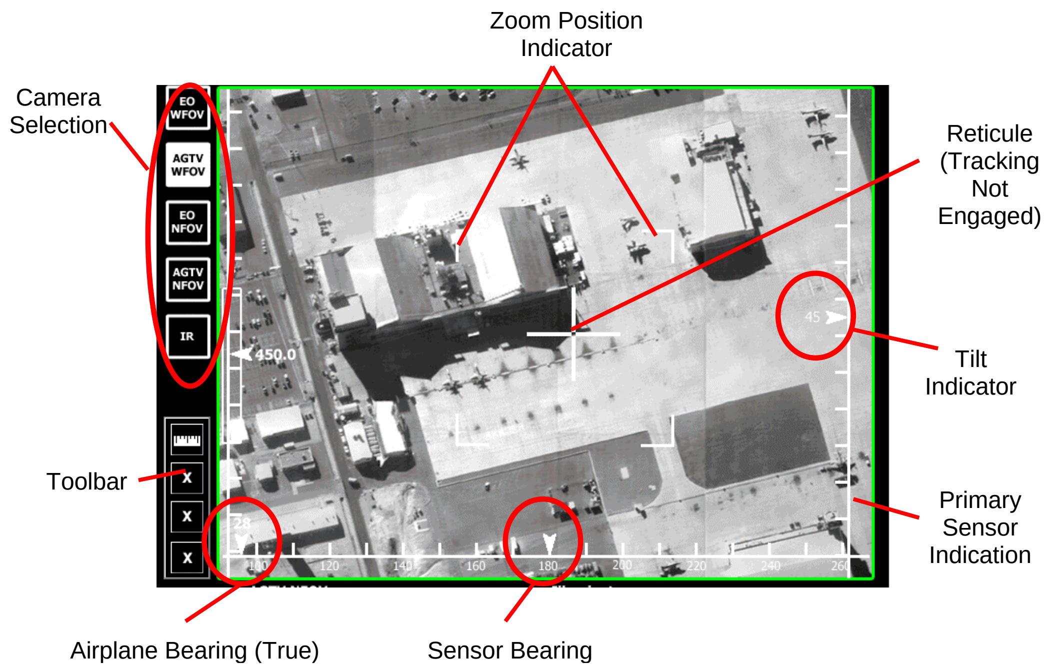

Figure 7. *Primary Sensor Window with Overlays*

b. **Zoom Position Indicator.** The zoom position indicator graphic is the corners of a rectangular box centred around the reticule. The box encloses the area on the image which would be displayed at the next FOV setting. For each sensor window, the zoom indicator is only affected by the FOV selection with the exception of the IR camera which has an electronic zoom capability. At the maximum FOV setting, the zoom position indicator would not be shown. This overlay would not be present on the imagery for sensors possessing a continuous zoom (ie. AGTV WFOV, AGTV NFOV, colour camera WFOV) as opposed to discrete FOV settings

c. **Camera Tilt Indicator.** On the right side of the primary sensor window, a camera tilt indicator consists of an arrow which moves up and down the right border of the window to give a relative indication of tilt angle, where the top of the window represents a high tilt angle. A digital readout is also provided to give the current tilt angle in degrees. A negative sign is used for angles below the horizontal. A see-through graphic was selected to minimize the impact on the viewing area.

d. **Camera/Aircraft Bearing Indicator.** The bottom of the primary sensor window provides a sliding scale with a stationary solid arrow and readout to denote the true bearing of the sensor. The outline arrow denotes the true bearing of the aircraft. The aircraft bearing arrow will slide along the scale with a readout to represent the true bearing of the aircraft. If the aircraft bearing does not fit within the bearing range of the represented scale on the primary sensor window, the aircraft bearing arrow will remain on the left or right side of the scale. If the aircraft bearing and sensor bearing become aligned, the aircraft bearing arrow will slide across the scale and overlap the sensor bearing arrow.

e. **Gate Range and Depth Indicator.** On the left side of the AGTV sensor window is the gate range and depth indicator (Figure 8). The outline bar is used to provide a relative indication of minimum and maximum gate ranges (or depth). Moving on top of this bar is a smaller white arrow which represents the actual range as calculated by the map data. A digital readout of the actual gate range in metres is provided as an annotation which moves with the arrow.

f. **Contact indicators.** Indicators for contacts of interest that are displayed on the moving map are duplicated in the sensor window to support correlation of incoming imagery to the moving map display.

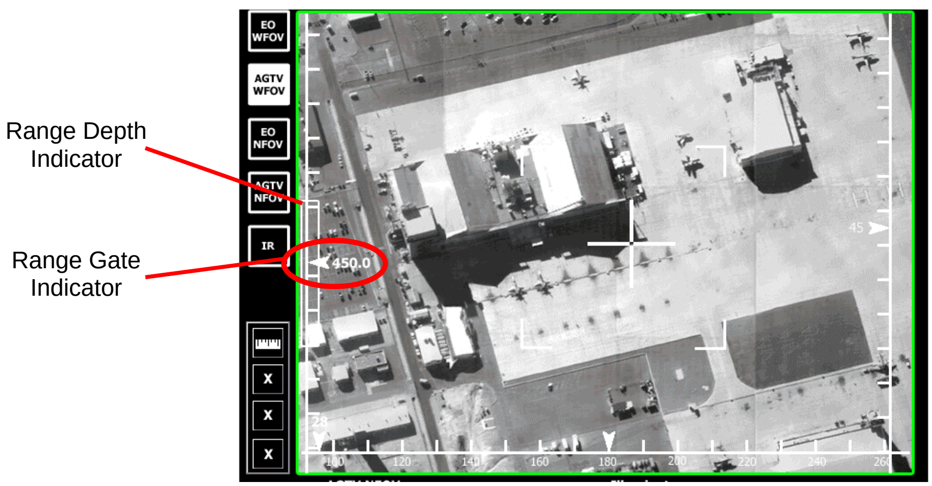

Figure 8. *AGTV Sensor Window Overlays*

Sensor Window Controls

Associated with each sensor window are two groups of controls: camera selection and toolbar (Figure 9). The camera selection buttons are a series of mutually exclusive buttons that correspond to the sensor thumbnails. Selecting a button will display the raw imagery from the associated camera in the sensor window.

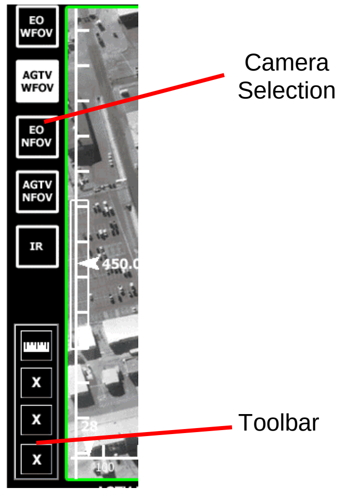

Figure 9. *Camera Selection Controls and Toolbar*

Discussions with the CP-140 operational community indicated a series of desirable controls to interact with the sensor windows to better accommodate the anticipated operations overland in conjunction with the LF. Functions for consideration include the ability:

a. to measure the size of a target to support classification activities;

b. to determine the geo-positional data for a given location on the image without being forced to centre the location in the middle of the displayed imagery; and

c. to measure distances as accurately as possible between two points of interest (e.g. to support missions as a forward observer for artillery).

This functionality could be accessed via the adjacent toolbar buttons and the cursor control device. The exact design of toolbars will be dependent on the functionality to be accessed by the toolbar buttons.

Sensor Window Status

For the ELVISS system, sensor status information was presented to the operator as an overlay on the sensor windows due to constraints in screen space. The level of detail displayed for each sensor was operator-defined according to four settings (Part Status, Part Plus, Full, and None). Given the additional screen real estate available on the primary AIMS display as well as the SMEs' preference for minimizing "clutter" on the incoming imagery, status information was relegated to panes directly below the associated sensor window. This information is context-sensitive depending on the source of the incoming imagery for the given sensor window and correlates with the settings (camera and laser illuminator) adjustable via the Sensor Control Panel. For instance, Figure 10 illustrates the sensor status for the AGTV NFOV which includes a pane for the camera status and another for readouts specific to illuminator performance. Illuminator system status information (e.g. active/passive, armed/disarmed) is reserved for the Alerts and System Status portion of the primary AIMS display (refer to Section 5.2.5). Whereas, Figure 11 illustrates the pertinent status information related to the IR camera.

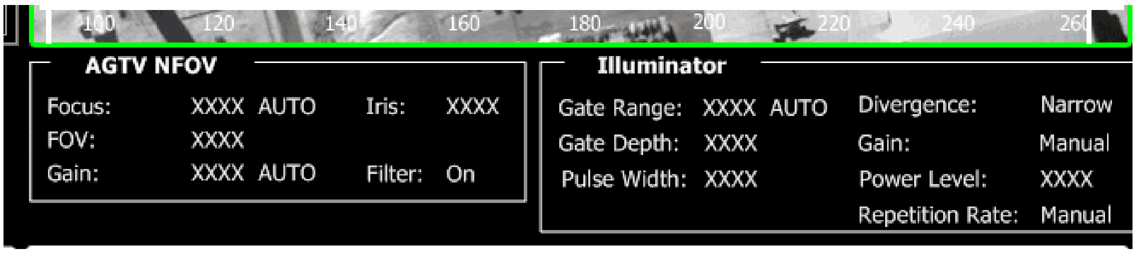

Figure 10. *AGTV NFOV and Laser Illuminator Status Information*

Figure 11. *IR Status Information*

The CP-140 community did not perceive the sensor status information as essential for conducting an operation.[8] Although, there is a benefit to retaining this information within the operator's primary field of view so as to provide visible feedback upon actuation of controls on the sensor control panel. Given the contradictory requirements, the operator will have the ability to personalize the presentation of status information through four settings located in the on-screen tabs of the primary display, similar to the ELVISS design:

a. **Part Status.** Part status information provides the operator with minimal textual clutter below the sensor window. Only those pieces of information considered essential for the operation of the sensor are displayed.

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[8] The SAR community expressed a similar preference during the predecessor analysis. Information of this nature was included for the benefit of the stakeholders from the scientific community to support research objectives.

b. **Part Plus.** The Part Plus display of status information provides the operator with status indications for sensor controls which are currently set to manual, but are normally set to automatic. When the operator selects a function like Iris setting to manual, the Iris setting is added to the status area for as long as the control is in manual. Not only does this feature provide a numeric or textual readout for the setting, but it also serves to remind the operator that the setting is being controlled manually.

c. **Full.** The option to display all relevant sensor parameters is included as the Full option. It is expected that this setting would only be used by an experienced sensor operator.

d. **None.** Finally, the operator can choose to completely hide the status information. All of the critical status information remains displayed within the on-screen tabs (sensor status tab) and therefore available by scanning. This option is intended for brief periods only, or for experienced sensor operators. A less experienced operator should have the key sensor settings displayed to avoid confusion.

The sensor status information is also displayed adjacent to the corresponding controls in the Sensor Control Panel area of the AIMS console.

5.2.2 Aircraft and Sensor Data

Discussions with CP-140 community indicated that the primary aircraft and sensor information requirements to support the majority of operations are true bearing, relative bearing, slant range (to support internal discussions), and horizontal range (to support operations with the LF).[9] This information is provided through a combination of readouts and polar plot (Figure 12).

The proposed polar plot for the AIMS system leverages the ALBEDOS design. As such, the polar plot consists of a fixed aircraft icon surrounded by range rings at distances of ¼, ½, and 1 nm. A camera position indicator originates at the centre of the aircraft icon. The vector direction indicates the camera angle relative to the aircraft and the vector length indicates the slant range to the object in the centre of the primary sensor window as calculated from the terrain data. When the vector terminates beyond the range rings, a slash is added across the end of the vector to indicate that the range is greater than 1 nm. During the ALBEDOS study, it was noticed that the length of the vector on the polar plot was found to be too small to be easily interpreted by the operator when the camera is pointing near the vertical beneath the aircraft. To accommodate, as the camera tilts downward past 75° the polar plot scale is expanded to magnify the camera vector to a size that is readily visible to the operator. Only the largest range ring is retained and scaled at ¼ nm. The

[9] Based on discussions with the CP-140 community, there is no operational benefit to displaying a pitch indicator (e.g. artificial horizon).

size of the aircraft icon in the polar plot is also magnified to make the scale change readily apparent.

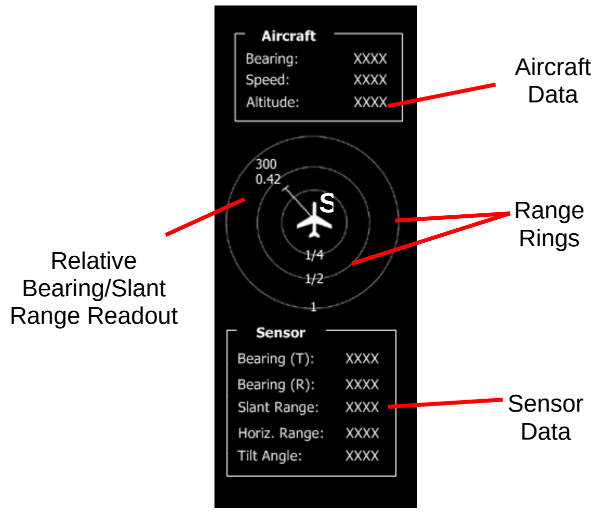

Figure 12. *Aircraft and Sensor Data with Polar Plot*

A letter appears when auto-tracking is selected to indicate the type of tracking that is active. The options include:

a. "S" for Scene (or position) tracking

b. "C" for Contrast tracking;

c. "CO" for Correlation tracking; and

d. "E" for Edge tracking.

Adjacent to the polar plot are complementary readouts for both aircraft and the sensor status information. The operator can relay either the clock angle from the polar indicator or an absolute bearing from the bearing readout, depending on the recipient of the information. Typically, the choice also depends on the range. A short range contact will usually be given in clock angle to enable the crew to quickly look in that direction. The absolute bearing is helpful to the pilot who may have to turn and home on the contact. Similarly, the operator can provide the slant range from the polar plot or horizontal range from the readout.

5.2.3 Sensor Thumbnails

On the left side of the primary AIMS display, thumbnails provide real-time imagery from each of the individual cameras (Figure 13)[10]. The thumbnails are arranged in the following sequence from top to bottom: colour camera WFOV, AGTV WFOV, EO NFOV, AGTV NFOV, and IR. The notion of the sensor thumbnails is to constantly provide the operator with the quality of imagery being captured by each camera as defined by its current settings. To that end, the thumbnails will assist the operator with determining the preferred sensor to employ given the environmental parameters. In many cases, this selection may be "obvious" as in the event of low lying cloud cover which dictates the use of an active-gated camera. In other instances, the selection of camera may not be as evident.

Figure 13. *Sensor Thumbnails*

In addition, the thumbnails may be used to provide a wide FOV of a given area in order to maintain SA while the larger sensor windows are used to zoom in to investigate a given area of interest. The ability to turn the sensor thumbnails on and off is provided to minimize visual clutter on the primary AIMS display.

5.2.4 On-Screen Tabs

The bottom right-hand corner of the primary AIMS display contains a series of tabs—each tab contains controls and status information functionally grouped. Controls and displays relegated to this area are neither critical nor accessed often. Access to the functionality on these tabs is done via the cursor control device.

Although not represented, it is anticipated that the on-screen tabs will provide the capability to utilize real-time image pre-processing algorithms (noise removal, edge enhancement, contrast improvements, etc.) and ATC algorithms. As this capability becomes more defined, the AIMS OMI will continue to evolve to address this functionality.

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[10] This figure illustrates the sensor thumbnails in a left to right configuration as opposed to a top-down configuration to save space.

Video and Still Imagery Tab

The AIMS system will record incoming video imagery from each camera. To that end, Figure 14 illustrates a conceptual design for controls to capture, review, and edit both single frame and video imagery. In this respect, the operator can:

a. capture still images in real-time through the Target Designate button on the hand controller; or

b. generate still images/video clips from the previously recorded video feed of a given sensor.

It is anticipated that the functionality resident on this tab will be accessed more frequently than other tabs.

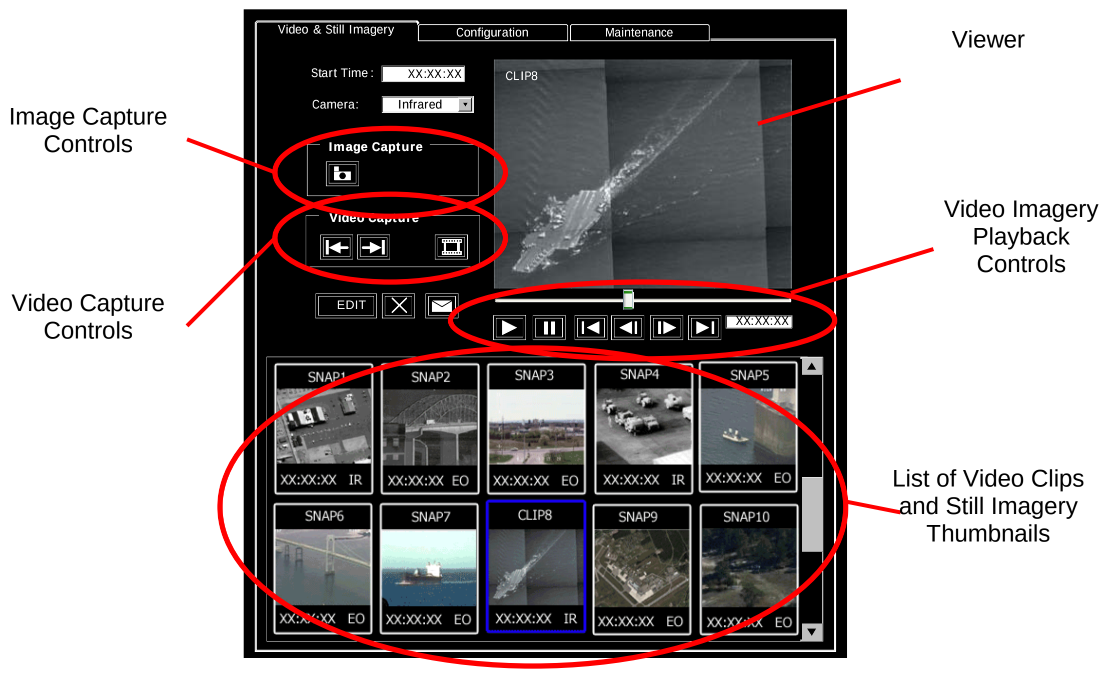

Figure 14. *Single Frame and Video Imagery Tab*

To review previously recorded imagery during a mission, the operator can select the desired camera and start time. Standard controls are provided for playing, stopping, pausing, fast forwarding, and stepping backwards. To capture still images from recorded imagery, the operator clicks the image snapshot button (button with a camera icon) which creates a thumbnail in the list below. Similarly, controls are provided to allow the operator to create "snippets" of video imagery. Stills and clips can be annotated and e-mailed to a predefined list of recipients. Templates for classified and unclassified e-mails could be readily available to support either type of transmission.

Thumbnails are presented in a list at the bottom of the tab for all still imagery and video clips that have been created by the operator. Selecting a thumbnail from the list with the cursor control device will present the image/video clip in the viewer for display to the operator. A scroll bar to the right of the list allows the operator to access thumbnails that are not currently visible.

Sensor Status Tab

This tab simultaneous displays all of the pertinent status data for each of the individual AIMS cameras and laser illuminator (Figure 15).

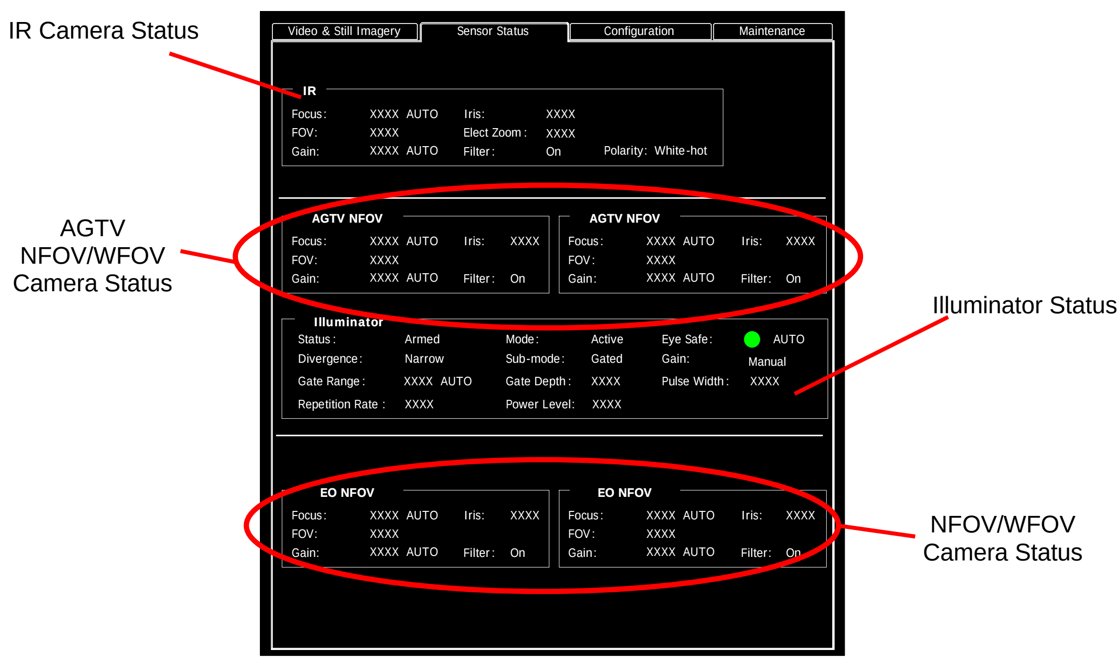

Figure 15. *Sensor Status Tab*

Configuration Tab

The configuration tab allows the operator to configure the layout of the primary AIMS display. Figure 16 illustrates notional controls that could be included to facilitate these activities.

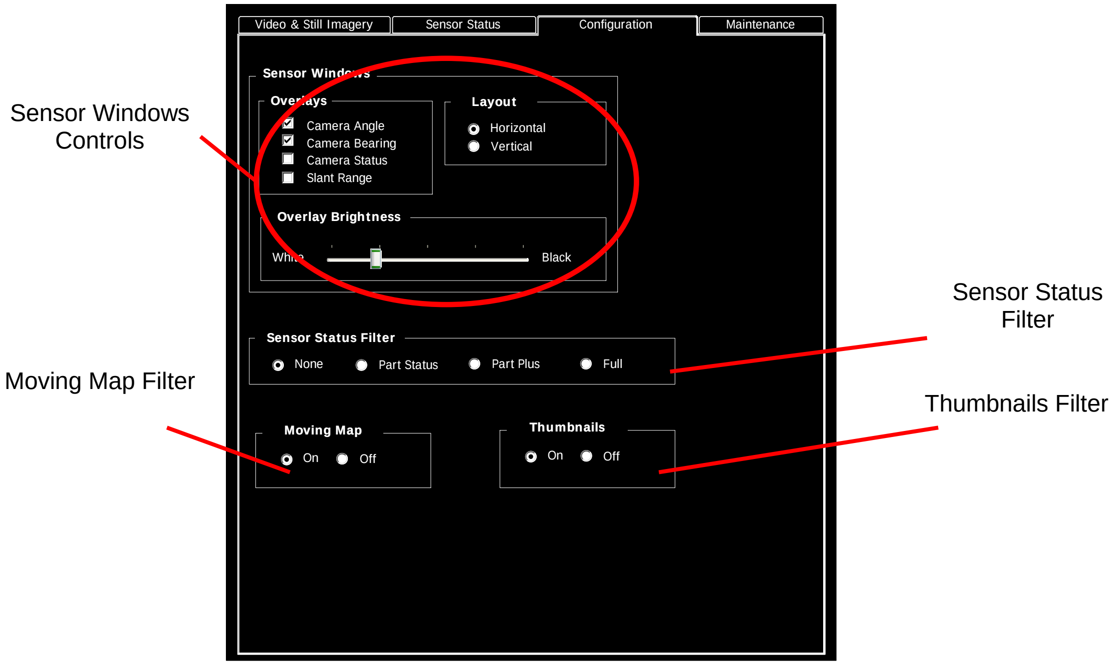

Figure 16. *Configuration Tab*

Maintenance Tab

The Maintenance Tab is reserved for status information that would result from built-in and calibration tests. For instance, placing the camera into the NUC mode could be accessed from this page. More investigation is required to determine the extent of this functionality.

5.2.5 Alerts and System Status

The top left corner of the primary AIMS display is reserved for continual presentation of system status information as well as non-critical alerts (Figure 17). Although not fully defined at this point, it is envisioned that status data will be reserved for displaying information resident on secondary tabs (e.g. Configuration and Maintenance tabs) that warrants continuous visual access by the operator. If needed, the operator can navigate to the appropriate tab for more details. For instance, the system information has been limited to displaying the status of power status and video recording.

For the laser illuminator, the mode, sub-mode, and status will be continually presented even when an AGTV camera has not been selected as one of the two primary sensors for displaying raw imagery to the operator. Of critical importance is the presentation of the relationship between the current gate range setting and the Nominal Ocular Hazard Distances (NOHD)[11] for both the naked eye and employing binoculars. The NOHD values represent the distance within which it is possible to exceed the maximum permissible exposure limits for a given laser which equates to the eye safety range for the AIMS system. For the ELVISS active imager, these values (at worst) were approximately 70m and 300m. Further investigation is required to determine the NOHD values for the AIMS system.

System warning information which requires immediate operator response is presented using large red lettering across the top of the Primary sensor image. The indication provides a statement of the condition and the immediate operator actions required to respond to the condition, e.g. "Laser Overtemp! Turn Off Illuminator!".

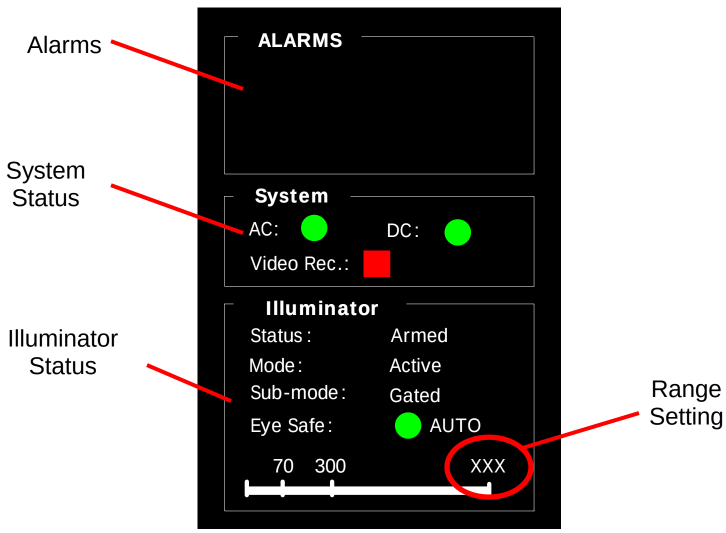

Figure 17. *Alert and System Status*

5.2.6 Digital Moving Map Display

For the AIMS OMI, the moving map has a reserved spot on the primary display as well as on an independent screen. An enlarged view of the moving map display format is provided in Figure 18. The moving map display format consists of the following elements and overlays:

a. moving map with current position at the centre;

b. aircraft symbol at the centre of the map;

[11] The NOHD is calculated for any light source in accordance with an international standard [Reference 24].

c. history track of the aircraft path;

d. camera orientation and footprint indicator;

e. camera history trail;

f. map scale indicator;

g. compass north pointer;

h. slew-to-cursor designator symbol; and

i. numbered contact markers.

The AIMS operator can display and hide overlays through a selection list that is accessible through a touchscreen button.

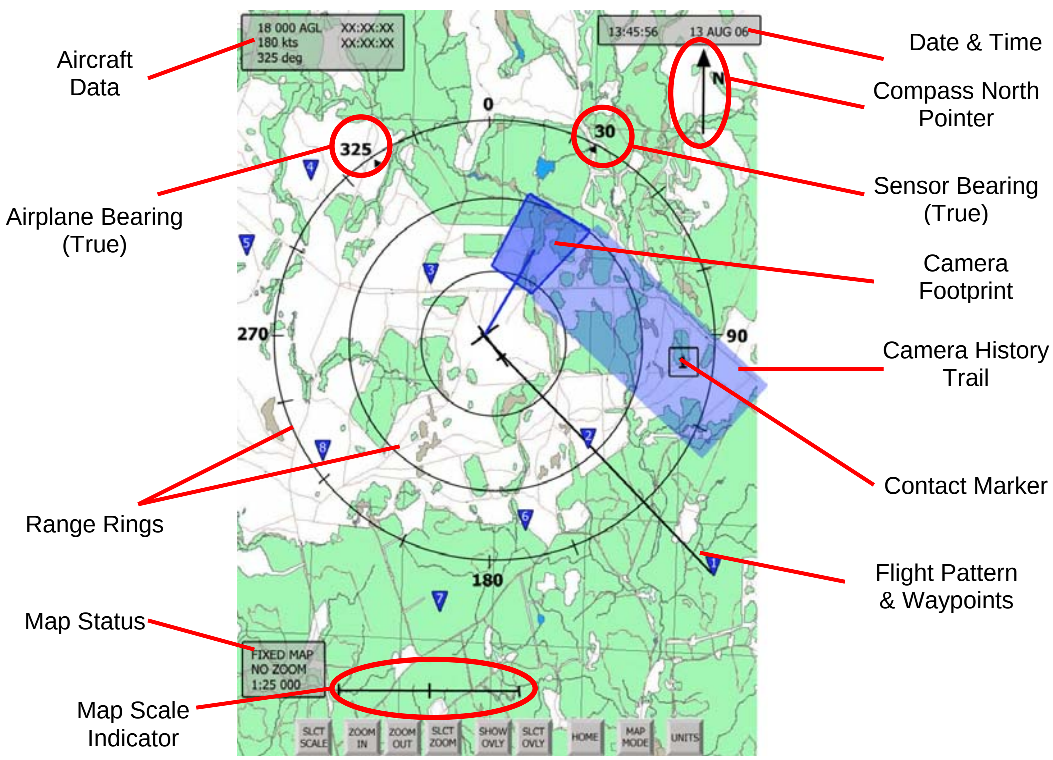

Figure 18. *Digital Moving Map Display with Overlays*

Moving Map

The moving map may be scaled from 1:25,000 to 1:1,000,000. In addition, an electronic zoom is available for all map scales ranging from 25% to 400%.

Although the map information is the same for a given map scale, a "zoomed" setting can make it easier to see the camera trail and estimate search area coverage.

The mode of the map display can be varied between moving and fixed. When in moving mode, the aircraft will remain fixed in the middle of the display with the map continuously updated in real-time based on the aircraft current position. In this mode, the map can be set to north up, heading up, or track up. In fixed mode, the map will remain fixed with the airplane icon moving in real-time across the display.

Map Scale Indicator

A standard linear map scale indicator is provided at the bottom left of the moving map display. The map scale indicator should also be augmented with grid lines if possible to improve operator awareness of distance on the map.

Map Settings

Adjacent to the map scale indicator, the map mode (fixed vs. moving), zoom setting, and scale setting for the current moving map configuration are displayed.

Compass North Pointer

A north-pointing compass arrow is located in the upper right hand corner of the moving map display.

Date and Time

The current date and time is displayed continuously at the top right of the moving map to help the operator keep track of mission progress.

Slew-to-Cursor Designator

The trackball controls the movement of a crosshair cursor on the moving map display. When a position is selected on the moving map using the Position Designate button beside the trackball, an off-white crosshair is deposited on the moving map at this location. The deposited symbol remains on the map until designated as a target or until a different location on the map is selected using the Position Designate button. The deposited crosshair represents the approximate location to which the camera will slew when the auto-slew button on the hand controller is activated.

Contact Markers

Contact markers are entered on the map by the target designate button on the hand controller. The markers are positioned in the location indicated by the AIMS footprint area on the map. The markers are white, consisting of a number enclosed in a box. The number remains in a vertical orientation regardless of the orientation of the map.

Known Crash Sites Overlay

To minimize time wasted investigating false contacts during a search, the system will display overlays of known crash sites as well as other objects that have been previously discounted as being the search object.

Electronic Locator Transmitter (ELT) Bearing

To assist with localizing a ELT hit, the moving map will display bearing lines to a radio signal on 121.5, 243.0, and 406.025 Hz as well as on any VHF frequency.

Aircraft Related Data

The following moving map overlays provide situational awareness with respect to the aircraft:

a. **Symbol.** The aircraft icon is used to indicate the current position and heading of the aircraft relative to the moving map. The icon remains in a stationary position in the centre of the moving map, but rotates according to the current heading of the aircraft (assuming a North Up map orientation). Range rings with numerical bearing marks and a bearing line from the aircraft could be used to represent the aircraft bearing. A standard fixed-wing icon from the ELVISS system has been retained for AIMS.

b. **Flight Track History.** A visual record of aircraft flight path is provided on the moving map display.

c. **Flight Plan Display.** The flight plan information including waypoints and routes are displayed on the moving map.

d. **Altitude.** To improve situational awareness, the aircraft altitude is provided at the top left in feet Above Sea Level (ASL) as the default or feet Above Ground Level (AGL).

e. **Geographical Coordinates.** The current geographical coordinates of the aircraft (latitude and longitude) are displayed at the top left corner.

Camera Related Data

Overlays on the moving map display related to the sensors include:

a. **Orientation.** Camera orientation is displayed on the moving map with a cyan vector originating from the centre of the aircraft icon. The relative orientation of the aircraft icon and camera vector changes to represent the camera panning angle. The length of the cyan vector is adjusted to indicate the approximate position at which the camera is pointing on the moving map, based on a trigonometric relationship between camera depression angle, aircraft altitude, and terrain height.

b. **Sensor Coverage.** A box representing the camera viewing foot print is attached to the end of the camera vector. The box is wider at the far end to show the effect of the field of view at this increased range. As the camera footprint grows and shrinks as a function of range and zoom or FOV settings, the box is adjusted to provide a close approximation of the terrain being viewed. The camera footprint is tied to the current primary sensor. As the operator switches the primary sensor, the box size and shape are adjusted to match the current sensor selection.

   As noted in Reference 18, the actual area covered by the cameras does not have a finite extent of most maps. Therefore, the OMI design must cover the situation where it is not possible to show the actual footprint on the moving map.

c. **History Trail.** A history of the trail on the ground viewed by the camera is provided as a cyan cross-hatched pattern. The pattern is drawn periodically on the moving map to represent the areas at which the camera has been pointing. A time relationship is introduced such that the density of the cross-hatching is relative to the length of time that the camera lingers on a particular location. The trail may be viewed, hidden, or erased by the operator as desired.

   Because the FOV of the individual cameras are usually different, the camera history trail may also be different. Therefore, the camera history trail being displayed is for the current primary sensor. To see the coverage of the other sensors, they would have to be selected as the primary sensor.

Sections of overlay representing the area covered by the camera are visually differentiated to indicate:

a. Regions searched with reduced sensor effectiveness due to obscuring weather phenomena such as low cloud cover between the aircraft and the ground (Figure 19). These regions could be tagged through the Cloud Cover switch that is located on the hand controller; and

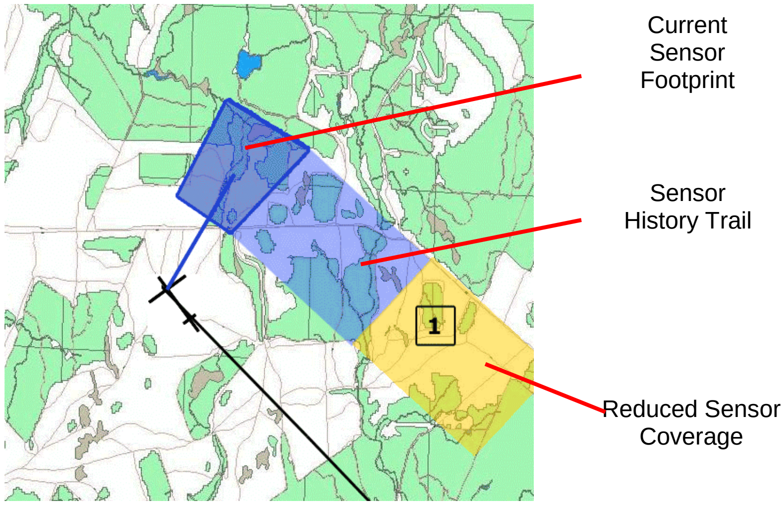

Figure 19. *Reduced Sensor Coverage Overlay*

b. Ground areas masked by terrain and therefore not viewable by the operator (Figure 20). These regions could be determined by the system through an accurate geo-reference system or image processing techniques.

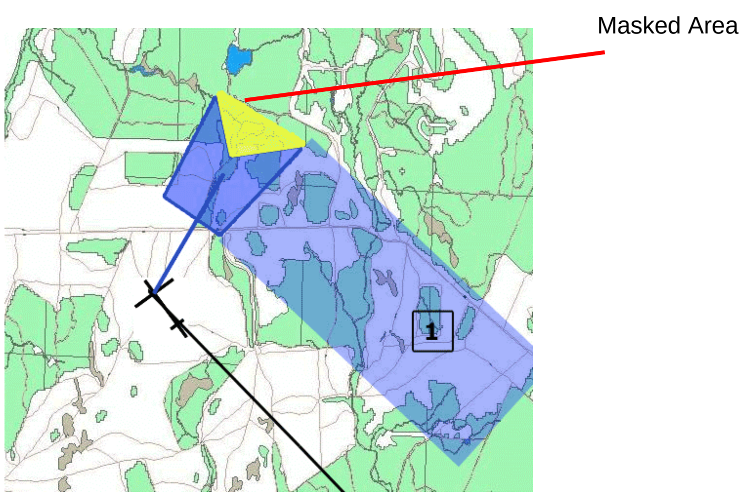

Figure 20. *Masked Ground Areas Overlay*

5.3 Controls

In addition to the GUI controls resident on the primary AIMS display, the AIMS console design employs the following array of controls as depicted in Figure 3:

a. **Hand Controller.** This is the primary functional control for the sensor turret. These controls are integrated into a pistol grip on the right side of the working surface. The frequency of use of these controls is assessed as being frequent and having a high criticality rating. Controls include pan and tilt (manual slew), automatic slew to a designated position on the moving map, target designate, automatic tracking and cloud cover.

b. **Sensor Control Panel.** This provides the primary controls for the sensors and laser illuminator through a combination of hard controls and touchscreen buttons.

c. **Moving Map Controls.** This provides functional control of the digital map through a cursor control device and touchscreen buttons.

d. **Cursor Control Device.** The trackball is the primary controller for accessing all soft controls resident on the primary AIMS and digital moving map displays.

e. **Keyboard.** To support entry of alphanumeric data, a keyboard is included in the overall AIMS workstation.

f. **Display Setting Controls.** Along the bezel of each display, controls allow the operator to adjust the quality of the associated image.

5.3.1 Hand Controller

The hand controller is a fixed pistol grip with a movable thumb controller and switches which incorporate the functions described in the following subsections. The hand controller employed for the rapid ELVISS prototype with a minor modification is recommended for use with the AIMS system (Figure 21).

Pan and Tilt

Camera pan and tilt are controlled via an omni-directional chinese hat conveniently located on the hand controller for use with the thumb. Moving the hat away from the operator tilts the camera up while moving the hat toward the operator tilts the camera down. Moving the hat left and right pans the camera respectively left and right.

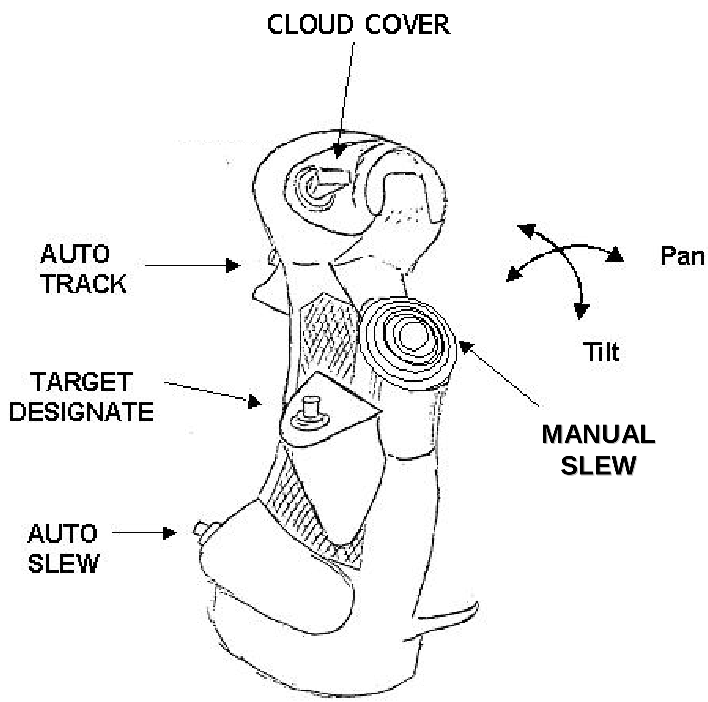

Figure 21. *Hand Controller*

Auto-Slew

Pressing the auto-slew control causes the camera to slew to a pre-selected location on the moving map. The operator defines the position on the moving map by using the trackball to move a cursor to the desired location on the moving map and pushing the designate button adjacent to the trackball. Pushing the button deposits a crosshair overlay on the map at the selected location. The crosshair remains until a new location is designated.

If no location has been pre-selected, the camera slews to the aircraft heading at a default depression angle. A depression angle of 15° was used for the ELVISS prototype. This depression angle could be retained for the AIMS system or a default look-ahead distance could be specified.

Auto-Track

If an operator finds an object of interest to track, the contact can be centered on the screen and squeezing the auto-track switch toggles the primary camera in and out of auto-tracking mode. When the system is in Auto-Track mode, the gain of the pan and tilt controls is reduced by a factor of 10 to provide precise positioning control. Even though there are different types of auto-trackers (Geo-Track or Scene, Contrast, Correlation, and Edge), the AIMS design assumes that one type of auto-tracker can be set up and left as the default, suitable for the majority of tracking tasks. Therefore, the AIMS operator needs only to toggle the auto-tracker on and off. The OMI design will permit the operator to change the type of auto-tracker at any time except when the primary sensor is actively in “track mode”. Similarly, if the auto-track mode has been activated, the operator will not be able to change the primary sensor unless the auto-track mode is deactivated.

Target Designate

Pressing the target designate button marks the current search location on the moving map with a numbered marker then takes a snapshot of the current search location (as presented in the primary sensor window) and displays the snapshot in the viewer on the Video and Still Imagery tab. A thumbnail is also presented in the list at the bottom of the tab. It remains to be determined the amount of metadata to be stored in addition to the snapshot upon pressing the target designate button.

Since the target designate function is usually done upon engaging auto-track, the thumb is not required for manual operation of the pan/tilt functions and is free to press the target designate button.

Cloud Cover Control

This switch can be used to denote times during the search whereby weather is impeding the quality of the search. Feedback is provided through an overlay on the moving map (Figure 19).

5.3.2 Sensor Control Panel

The Sensor Control Panel is the primary means of manipulating the sensor and laser illuminator parameters as well as turning the system power on and off. A conceptual design for this panel is presented as Figure 22. All of the basic functionality required to operate each camera and the illuminator are right at the user’s finger tips. The panel is a combination of hard and touchscreen controls including the following:

a. **Toggle switches.** These switches are vertically oriented for all functions that have two discrete states. For example, the ability to place the laser in a safe or armed state is controlled by a toggle switch. Each switch is labelled and, where appropriate, a LED is located in close proximity to visually confirm the selected state.

b. **Pushbutton.** Only one pushbutton has been included in the sensor control panel in order to provide the operator with the ability to quickly invoke a critical action. In this instance, an override button was provided to allow the operator to quickly override the manual mode for eye safety.

c. **Rotary control knobs.** These knobs adjust functions that involve a continuous setting such as focus, gain, as well as the gate range and depth. Turning a rotary knob clockwise will increase the value and counter clockwise will decrease the value.

d. **Touchscreen buttons.** To adjust sensor settings and select the primary sensor, touchscreen buttons have been designed.

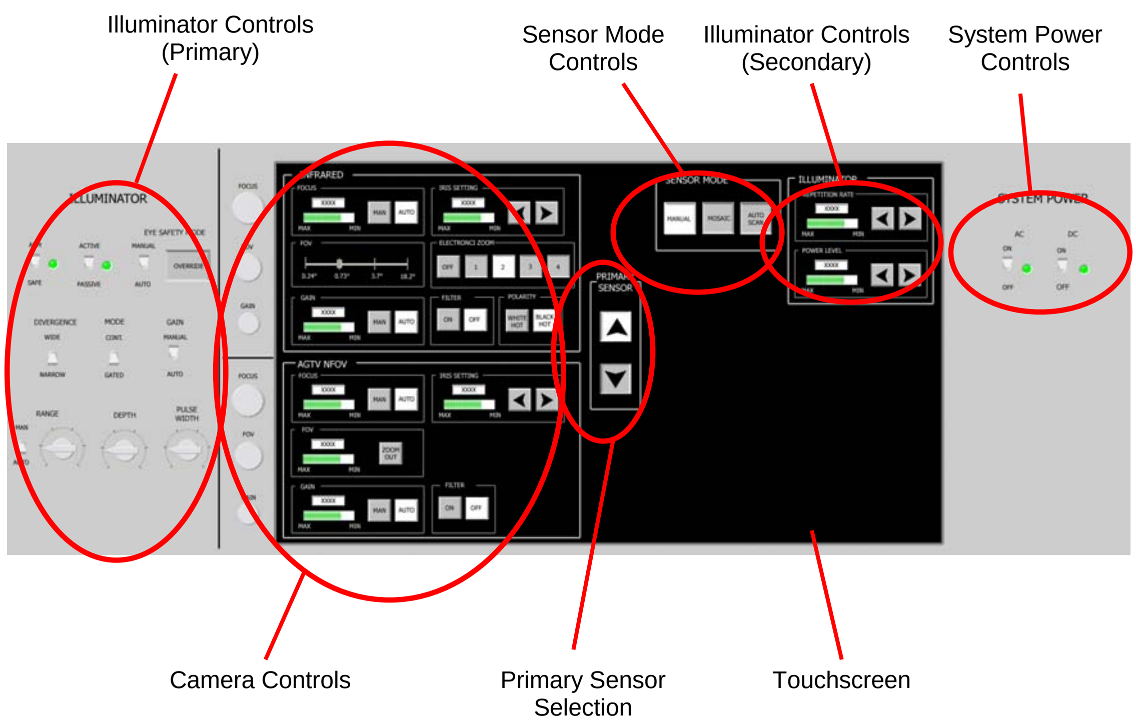

Figure 22. *Sensor Control Panel*

Similar to the ELVISS system, the AIMS design calls for an extensive use of automation and pre-set defaults in order to reduce the underlying complexity of the sensors. As the early ALBEDOS trials showed, even a well-trained, experienced sensor operator would have difficulty operating these sensors if there were no automation. Although the level of complexity has been greatly reduced by the operator interface design, the lower level functionality has been retained within the touchscreen for use by experienced sensor operators and for use during flight trials and evaluations. It is intended that the normal

AIMS user could operate the sensors successfully without ever using the lower level functionality during a mission.

Laser Illuminator Controls (Primary)

The left portion of the sensor control panel is reserved for the switches, buttons, and rotary knobs related to the camera gating of the AGTV system (Figure 23). These controls have been arranged in three rows of controls.

Figure 23. *Primary Laser Illuminator Controls*

For the top row, the laser illuminator controls from left to right are:

a. **Laser Armed/Safe Switch.** The two-position Laser Armed/Safe toggle switch provides power to, or removes power from, the laser illuminator. The “Arm” selection is inhibited unless the adjacent laser active/passive switch is in the passive mode. The “Arm” selection is inhibited by use of a spring loaded switch which returns to the “Safe” position when released unless the passive laser mode is selected. When “Armed”, the status light beside the switch is illuminated to give strong operator feedback.

b. **Laser Active/Passive Switch.** The Laser Active/Passive toggle switch activates and selects the mode of operation of the laser illuminator:

passive or active. In active mode, the laser is operational whereas in passive mode, the laser ceases to operate. When "Active", the status light beside the switch is illuminated to provide visual feedback.

c. **Eye Safety Mode Switch.** The Eye Safety Mode switch engages, or disengages, the automatic safety mode for the laser. In automatic mode, the laser power is adjusted in accordance with a range as calculated by the geo-reference system. In manual mode, the laser power level is adjusted through the Power Level touchscreen buttons. As a safety precaution, an Override button provides a single action function to inhibit all lasing activity. This switch is a critical item which will be used infrequently, but requires immediate accessibility due to safety implications. The laser can be turned off or made safe, but in an emergency, the Override button can stop all laser radiation with a single press.

The second row of laser illuminator controls starting from the left are:

a. **Laser Divergence Switch.** The two-position toggle switch controls the percentage of the sensor FOV that will be illuminated by the laser. The divergence of the laser can be either narrow (0.7°) or wide (5.0°).

b. **AGTV Mode Switch.** The AGTV Mode control is a two-position toggle switch which affects all of the other range gate controls. When in the Continuous state, the gate on the intensifier gain is always on and the other range gate controls have no effect. When in the Gated state, the gate on the intensifier gain is synchronized with the laser pulses and the other range gate controls are enabled.

c. **Gain Switch.** The Gain control is a two-position toggle switch to activate or de-activate auto-gain mode for the laser illuminator and camera. In Auto mode, the gain (i.e. contrast level) of the camera is automatically adjusted in response to existing environmental conditions, aircraft altitude and speed, and other camera settings (i.e. lens extender setting, zoom factor, etc.). This function will also automatically adjust the laser illuminator parameters (i.e. power level, pulse width, divergence) when the laser is set to Active Mode.

From left to right, the third row of illuminator controls contains:

a. **Gate Range Switch and Knob.** The two-position Gate Range toggle switch sets the range gate to either Auto or Man. In automatic mode, the range of the camera gate is calculated by the geo-reference system (i.e. slant range from aircraft to the closest point of the area to be illuminated). In manual mode, the range is controlled by the operator and determined solely by the position of the adjacent rotary knob. The rotary knob for the Gate Range will be disabled when the Gate Range toggle switch is set for automatic operation. If the ability to make fine adjustments to the automatic range is required, the control design will need to be re-visited.

b. **Gate Depth Knob.** The AIMS operator manually adjusts the depth of the gate using this rotary knob.

c. **Pulse Width Knob.** The Pulse Width rotary knob is reserved for controlling the pulse width of the laser illuminator.

Camera Controls

All of the cameras embedded in the AIMS gimbal have a common set of functionality, as outlined in Table 2. Controls are required to allow the operator to adjust these parameters for each of the individual cameras.

Table 2. AIMS Camera Controls

CAMERA	FOV	GAIN	FOCUS	POLARITY	FILTER	IRIS	ELECT ZOOM
Thermal Imager (mid-wave IR)	4 settings (discrete)	Auto/Man & Cont. settings	Auto/Man & Cont. settings	Black/White hot	On/Off	Cont. settings	On/Off 4 settings (discrete)
EO NFOV (visible; Near IR)	4 settings (discrete)	Auto/Man & Cont. settings	Auto/Man & Cont. settings		On/Off, & Cont. settings	Cont. settings	
AGTV NFOV (Image Intensifier CCD)		Auto/Man & Cont. settings			On/Off 6 settings (discrete)	Cont. settings	
AGTV WFOV (Image Intensifier CCD)	Cont. settings	Auto/Man & Cont. settings	Auto/Man & Cont. settings		On/Off	Cont. settings	
Colour camera WFOV	Cont. settings	Auto/Man & Cont. settings	Auto/Man & Cont. settings			Cont. settings	

To accommodate the array of controls required to adjust the settings for all five cameras, a combination of hard and soft controls are proposed for the AIMS camera controls (Figure 24). The camera controls on the sensor control panel are limited to the corresponding primary and secondary sensors as selected and represented in the two sensor windows on the primary AIMS display. For instance, Figure 24 depicts controls for configuring the IR and AGTV NFOV cameras.

Primary camera functions that require frequent access and/or kinesthetic feedback to facilitate their operation are accessed through hard controls.

Secondary camera functions can be adjusted via soft controls located in the touchscreen portion of the sensor control panel. As such, the controls as displayed on the touchscreen will vary in accordance with the sensor selection on the primary AIMS display.

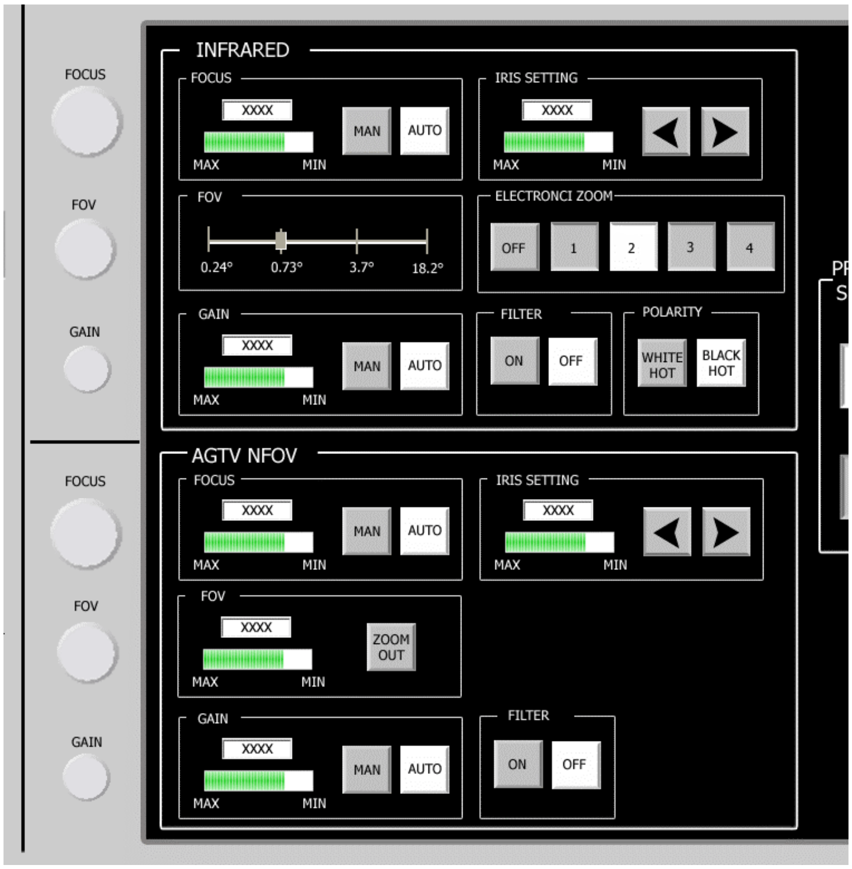

Figure 24. *Camera Controls*

To the left of the touchscreen, rotary knobs are provided for the focus, FOV, and gain[12] functions. Each control is spring-loaded so it returns to centre, and it provides a rate proportional output so that the more the knob is rotated, the faster the parameter changes. Normally, the AIMS operator will leave the focus and gain settings in automatic mode. Therefore, the rotary knob would be used to make minor adjustments, if needed. Adjacent to each focus, FOV, and gain rotary knob, in the touchscreen portion of the sensor control panel, is a readout of the control's current setting accompanied by a scale providing a

[12] This rotary knob for the gain control will only impact the settings for the individual camera. Whereas, the gain toggle switch (located with the primary laser illuminator controls) will adjust the camera gain setting in conjunction with the laser illuminator parameters to obtain the 'best' image.

relative indication of its setting. In addition, pushbuttons are provided for toggling the focus and gain functions between manual and automatic mode. Settings for these functions are also presented on the primary AIMS display (in panes below the sensor windows) since the operator will typically be looking at the incoming imagery while adjusting the setting in order to gauge the effect.

The remainder of the camera controls, in accordance with Table 2, are presented as soft controls on the touchscreen. For instance, the top portion of Figure 24 groups together the IR controls and associated visual feedback for adjusting the iris setting, IR polarity, electronic zoom, and filter. Whereas, the bottom portion of the touchscreen contains the controls for adjusting the AGTV NFOV

Primary Sensor Selection

Despite displaying imagery in two sensor windows on the primary AIMS display, only one sensor can be designated as the primary sensor at a given time. As such, two arrow buttons in the middle of the touchscreen allow the operator to toggle the selection of the primary sensor between the two currently selected sensors on the primary AIMS display (Figure 25). Upon selecting the primary sensor, the corresponding overlays will be mapped on to the video imagery in the appropriate sensor window. The primary window selection also designates the camera which will respond to auto-track commands input by the operator.

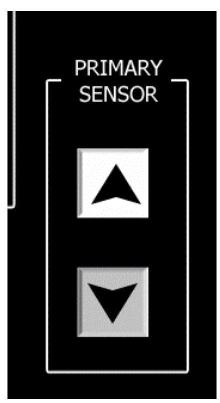

Figure 25. *Primary Sensor Selection*

Sensor Mode Selection and Configuration

The AIMS system can be operated in three modes: Manual, Auto Scan, and Mosaic. The three corresponding touchscreen buttons provide mutually exclusive selection of the three modes. In Manual mode, no additional settings have been identified. Whereas in the Auto Scan and Mosaic modes, additional parameters will have to be configured in order to support the use of system in these modes. Figure 26 illustrates notional controls for configuring and invoking the mosaic mode of operation. The operator would first select the particular sensor for utilization. Based on aircraft data (i.e. course, speed, altitude), the operator could have the system calculate the recommended sensor settings for implementation of the mosaic mode. If the operator agrees with the recommendation, pressing the ‘Configure Camera’ pushbutton would adjust the sensor in accordance with the proposed settings. Finally, the operator would activate the mosaic mode by pressing the ‘On’ button.

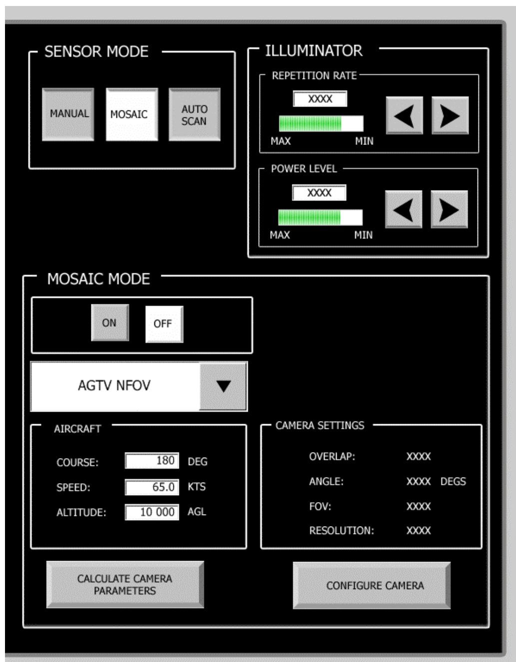

Figure 26. *Sensor Mode Selection and Configuration*

Laser Illuminator Controls (Secondary)

Secondary laser illuminator controls that are not accessed frequently have been moved to the touchscreen (Figure 27). The first set of buttons allows incremental changes to the repetition rate. A similar convention is employed for adjusting the pulse width setting. Periodically throughout the mission, the operator will adjust these settings. A trade-off was made to move these controls onto the touchscreen as opposed to co-locating with the remainder of the primary laser illuminator controls.

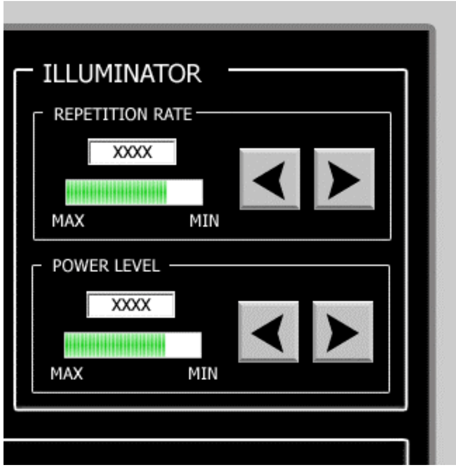

Figure 27. *Secondary Illuminator Controls*

System Power Controls

A dedicated two-position, On/Off switch is required for both alternating current (AC) and direct current (DC) system power to the AIMS console. Each switch will be used infrequently during a mission and is located on the side of the console in a recessed position to avoid accidental activation. Adjacent to each switch is an LED which will illuminate upon application of power to the system.

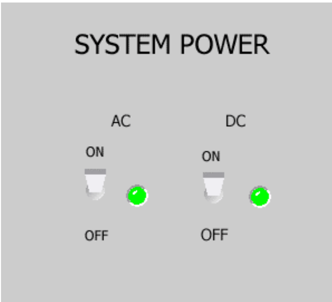

Figure 28. *AC and DC System Power Controls*

5.3.3 Moving Map Controls

The controls used to manage the Moving Map are grouped at the bottom of the map. These functions are accessed infrequently and are reserved for configuring the moving map display. Further investigation is required with respect to the distribution and duplication of controls across the two moving maps as well as their independence (i.e. Can the maps be configured separately or is one map slaved to another?)

Irrespective of the aforementioned issues, the following sections describe a notional control arrangement for configuring the larger moving map on the secondary screen adjacent to the primary AIMS display (i.e. moving map display). For this purpose, a series of touchscreen buttons has been proposed. If the miniature moving map on the primary AIMS display is to employ a similar suite of controls, the touchscreen pushbuttons could be swapped for a series of buttons accessible through the cursor control device.

Moving Map Touch Screen Controls

Across the bottom of the larger moving map, a series of touchscreen buttons invoke semi-transparent dialog boxes for configuring the moving map as well as invoke immediate actions. Moving from left to right, the buttons control the following functionality:

a. **Map Scale.** The operator can select the scale for the moving map from a predefined list through the 'SLCT SCALE' button (Figure 29). The checkbox at the bottom of the dialog box allows the operator to set the ability for the system to automatically adjust the scale value if the zoom is changed.

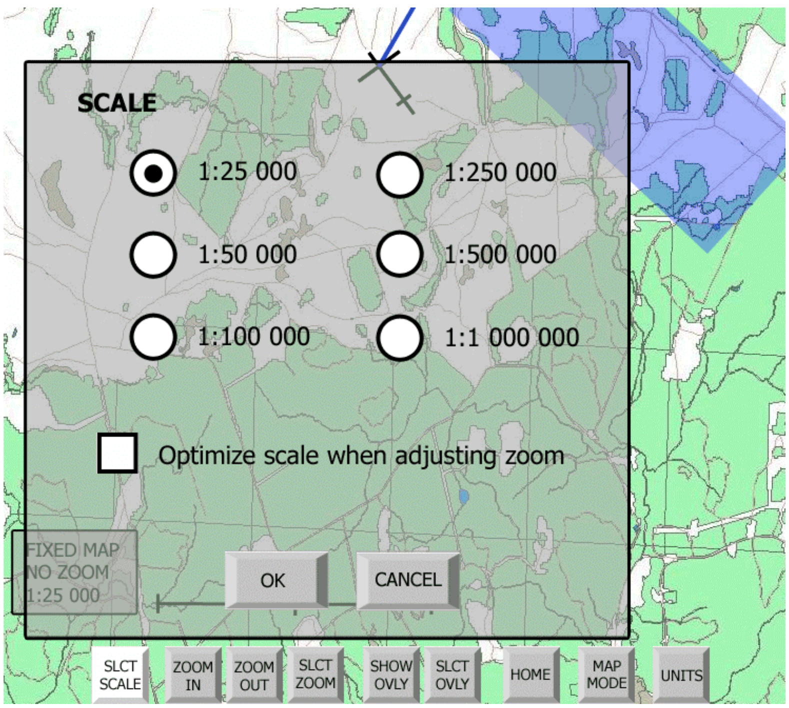

Figure 29. *Scale Dialog Box*

b. **Zoom Factor.** The operator can either adjust the zoom factor in a step fashion by selecting the 'ZOOM IN' and 'ZOOM OUT' buttons or select a zoom value between 25% and 400% via the ‘SLCT ZOOM’ button (Figure 30).

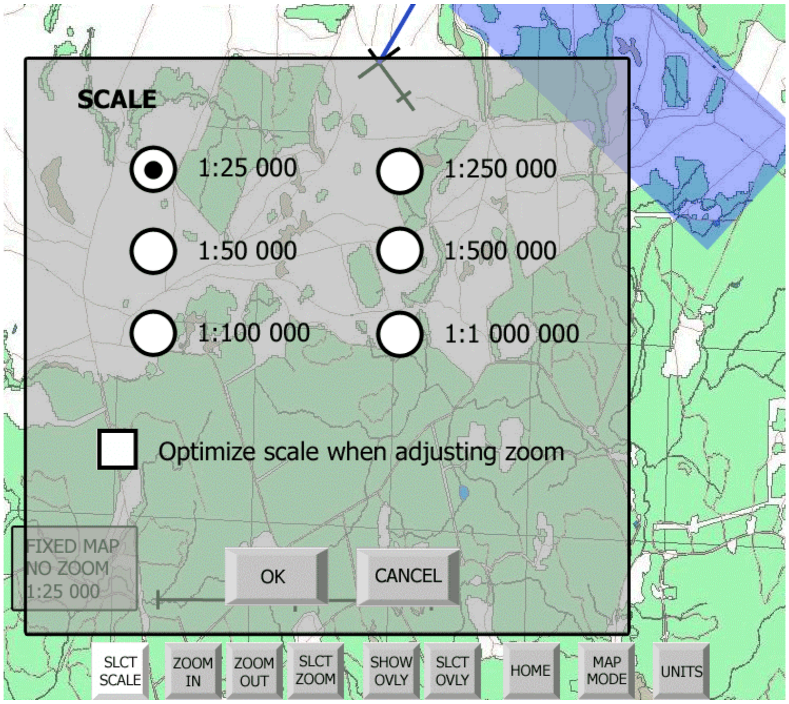

Figure 30. *Zoom Dialog Box*

c. **Overlay Management.** The operator has the ability to display and hide overlays through a selection list that is invoked by the ‘SLCT OVLY’ button (Figure 31). The ‘SHOW OVLY’ button provides the operator with the ability to quickly turn overlays on and off as per the configuration stipulated.

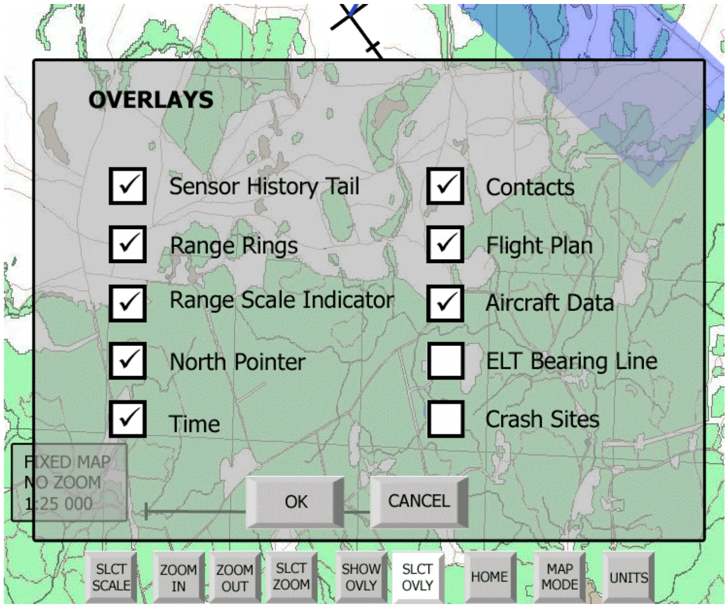

Figure 31. *Overlay Selection Dialog Box*

d. **Mode.** The 'MAP MODE' buttons invokes a dialog box with the option to select the moving map mode (moving or fixed) from two radio buttons. In the moving map mode, the map is displayed in real-time with reference to the aircraft position and heading. The moving map orientation can be selected from either north up, heading up, or track up. When the map is fixed, eight panning buttons will be displayed to allow panning of the map along any axis.

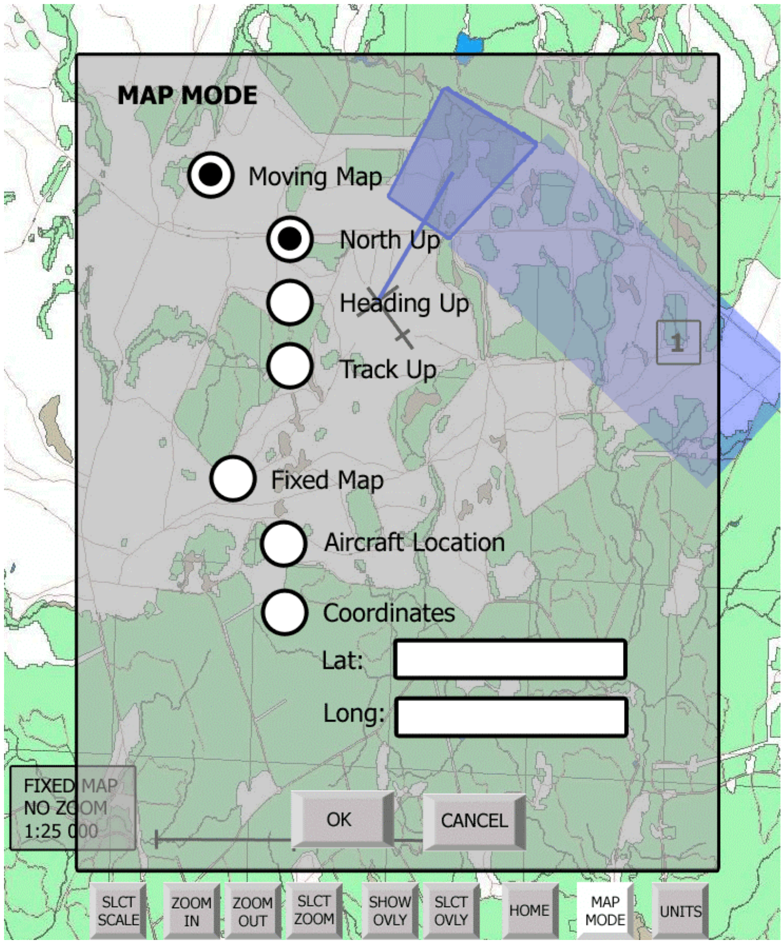

Figure 32. *Map Mode Dialog Box*

e. **Unit of Measurement.** The unit measurements for the distance, coordinates, altitude, velocity, and bearing can be chosen from a pre-defined list accessed via the 'UNITS' button (Figure 33).

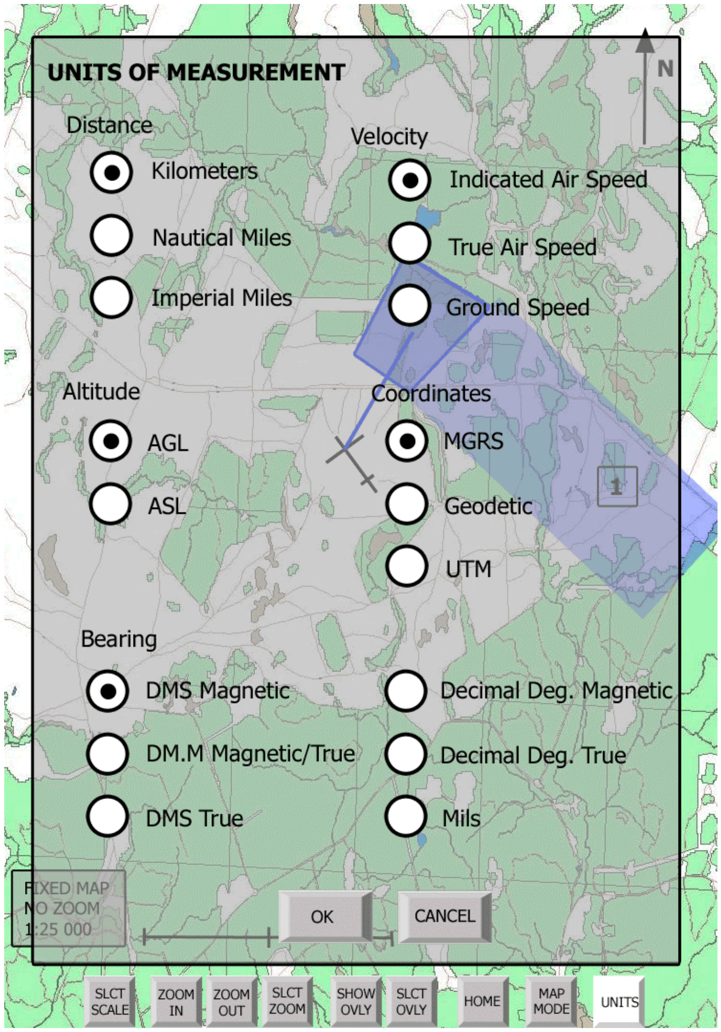

Figure 33. *Unit Measurement Dialog Box*

Moving Map Pointing Device Controls

The smaller moving map on the primary display has additional functionality residing in context sensitive menus that are accessible through right-clicking select objects. Provision of this functionality will allow the operator to perform a subset of tasks quickly. Figure 34 provides an example of a context sensitive menu for a contact marker.

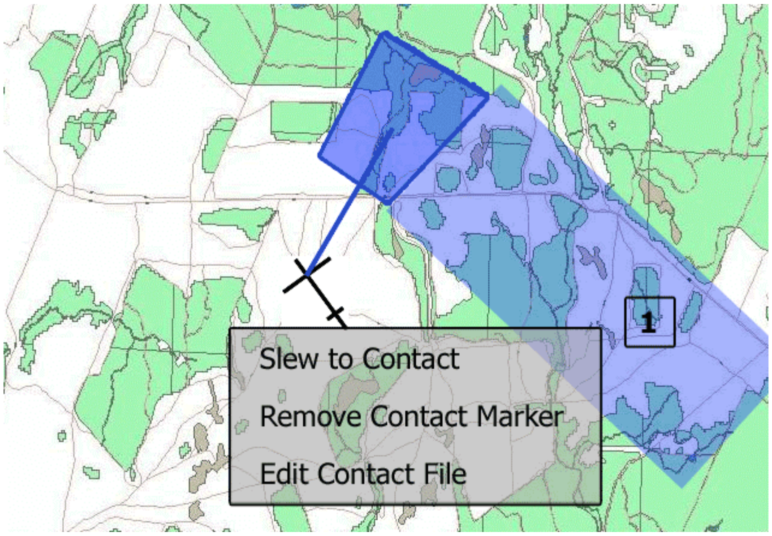

Figure 34. *Context Sensitive Menus*

5.3.4 Trackball

The trackball is used on the primary display to move the cursor across the moving map display, access controls residing within the tabs, select the imagery sources for the primary and secondary sensor windows, and to permit designation of positions on the moving map display. The on-screen cursor is controlled with the trackball using standard conventions for direction of movement.

The trackball unit is assumed to have two momentary switches. One is for the standard Select function. The second switch is labelled Position Designate in order to ensure unambiguous operation when the trackball is used to designate a position on the Moving Map Display for auto-slew.

5.3.5 Keyboard

The design of the AIMS OMI minimizes the requirement for using a keyboard during normal interaction. However, a keyboard is provided to support alphanumeric entry. The keyboard can be covered when not in use to increase the desk space.

5.3.6 Display Setting Controls

Along the bezel of each display, two rotary knobs control the brightness and contrast settings for the AIMS primary and moving map displays. Momentary overlays on each screen will provide feedback during control activation.

6. Design Rationale

6.1 General

Development of the AIMS OMI appearance and interactive style was based on the consideration of a number of factors including:

a. general human factors principles;

b. human computer interface design guidelines and heuristics;

c. a review of current literature regarding workstation display format design;

d. a review of ALBEDOS and ELVISS documentation provided by DRDC Toronto;

e. a review of ALBEDOS and ELVISS videotapes provided by DRDC Toronto;

f. information provided by a Task Analysis performed for both the CP-140 and FWSAR aircraft;

g. working groups with FWSAR and CP-140 SMEs;

h. consultation with DRDC Toronto and DRDC Valcartier; and

i. ongoing review of AIMS interface mock-ups.

6.2 Overall OMI Design Philosophy

Several mission-related factors combined to drive an overall AIMS OMI design philosophy. These factors included the requirement for situational awareness, communication requirements with other crewmembers, an understanding of the operator's mental model, and the need to minimize training requirements. Mission-specific factors involved the need for rapid contact identification and the tailoring of the AIMS design for small area searches. The most critical requirement was for a simple design with controls that could be quickly re-learned. The expected users of the AIMS system will vary depending on the aircraft. On the CP-140, a dedicated sensor operator will be responsible for the EO/IR system. In contrast, the primary operator of the EO/IR system on the FWSAR aircraft will not be solely responsible for this piece of kit.

The requirement for speed and efficiency during the conduct of a multitude of missions demands a well-designed operator interface which simplifies the primary tasks of searching, detecting, classifying, and identifying contacts for the crewmember. The following design constraints and guidelines form the basis of the design philosophy used in the development of the display formats:

a. provide quick access to all the basic controls/functions;

b. keep the interface simple to use through automation;

c. provide strong situational awareness cues;

d. provide clear feedback of all user actions; and

e. use natural, intuitive interface styles, cues and responses.

6.3 Screen Layout Rationale

6.3.1 Physical Parameters

The overall size of the display screen used for the rapid prototype and recommended for the production system was a compromise between a number of factors. The upper constraint on display size was the requirement for the display and workstation to consume as little space in the cabin of the aircraft as possible while still being functionally effective. The lower constraint was determined by the physical space required to effectively present all required display elements. A 17-inch screen with a display resolution of 1280 x 1024 pixels was defined for ALBEDOS. Similarly, ELVISS used a 17-inch flat panel screen; although with a lower display resolution of 1024 x 768 pixels. For AIMS, a larger 21-inch screen with a display resolution of 1600 by 1200 is proposed for the primary display. Larger screens could be proposed for the AIMS system since the anticipated installations would be in a fixed winged aircraft (CP-140 and FWSAR) which would have relaxed space limitations in comparison to the SAR helicopter cabin for the ALBEDOS and ELVISS systems. Although, further investigations may be required to ensure that the proposed design is conducive to the space limitations imposed by both the test platform (Twin Otter) and operational platforms (CP-140 and FWSAR).

6.3.2 Window Dimensions

The selection of sensor window dimensions was driven largely by the requirement to match the resolution of the displayed sensor images with the camera resolutions. Once this window size was determined, the location and size of the other windows was largely established. There was some concern that the size of the moving map display would not be adequate, however this concern proved to be unfounded as the SMEs expressed satisfaction with the map arrangement. The size of the freeze frame window also limits the fidelity of the stored images that can be displayed. This window size would not be satisfactory if image analysis was intended, however its use as a reminder to the operator of the appearance of the stored contact is acceptable.

6.3.3 Text Fonts

Minimum character height for alphanumeric and symbolic characters is based on MIL-STD-1472F requirements for subtended viewing angle (Paragraph 5.2.6.8.4). The minimum subtended viewing angle for characters is defined as 24 minutes of arc.

Based on the assumption of a viewing distance of up to 41 cm the minimum character height has been determined to be 2.86 mm. All displayed characters are at least 2.86 mm high. An interline spacing of at least 50% of the character height has been provided.

The text font for the AIMS display is Arial, a plain sans-serif font. The Arial font is simple, easy to read and provides a very clear distinction between all characters.

6.3.4 Display Colours

All incoming imagery, with the exception of the WFOV colour camera, is monochrome. In addition, the moving map is colour coded. To the greatest extent possible the use of colour for the remainder of the AIMS display has been kept to a minimum so as not to draw attention away from the primary image. As such, colour has been limited to drawing attention to abnormal system parameters, or where required to assist the operator in rapidly interpreting a display element. Abnormal system parameters use the MIL-STD-1472F standard colour conventions for alerts. Fully saturated colours have been used for the application of colour for purposes other than alerts because of their consistent appearance under the full range of dimming and area lighting arrangements.

The ELVISS study investigated ways to improve the contrast of overlays with the sensor video. The brightness and contrast of the sensor images may vary widely such that it is not possible to predict the best shade of grey for the overlays. The investigation was inconclusive and was not pursued further at this time. However, another option is to make the brightness of the overlays individually adjustable. This option was assumed when developing the preliminary menus. On the Configuration tab, overlays can be increased and decreased in brightness and the colour can be quickly switched between white and black.

6.3.5 Grouping common functionality.

Gestalt rules for human perception are used to increase the users' understanding of relationships between dialogue elements. For example, related groups of information are enclosed with boxes and task-specific controls are grouped together.

6.3.6 Placing the user in control.

Discussions with the operational community reflected personal differences with respect to the execution of tasks. As a result, flexibility was designed into the AIMS OMI to allow customization of the interface to support personal preferences as well as the variations in task requirements across operators situated in different aircraft (e.g. CP-140 NASO-1 vice FWSAR Senso).

6.3.7 Use and Placement of Sensor Windows

A driving design requirement for the AIMS OMI was to maximize the amount of screen real estate dedicated for displaying real-time video imagery. In turn, the operator can simultaneously perform critical mission functions such as maintaining SA, tracking contacts of interest, and monitoring areas of interest.

The real-time AIMS video imagery from operator-selected cameras is presented in two larger sensor windows on the left side of the display. The left side of the display was selected because the functions controlled by the operator’s left hand primarily affect the appearance of the incoming imagery. Even though the AIMS system is comprised of five sensors, the number of sensor windows on the primary AIMS display was limited to two—a similar configuration to ELVISS. In part, this design decision was based on the assumption that only a subset of sensors will be worth employing given environmental conditions due to their complimentary capabilities. For instance, missions conducted during night time or within adverse conditions may rely heavily on the IR and AGTV cameras while not leveraging the remaining EO cameras. The inclusion of the sensor thumbnails also allows the operator to continually monitor the remaining cameras that have not been selected for presentation within the sensor windows. Given the additional real estate afforded by the AIMS display, an area of research could investigate monitoring and managing more than two sensor windows, especially during periods of intense workload.

The use of overlaid information on the video imagery has been minimized, with most system parameters and other information being allocated to other areas of the display. This approach was based on SME input indicating that overlaid information can cause visual clutter and make interpretation of the camera image more difficult. The two graphical overlays provided on the video imagery are required to give the operator feedback of two important functions. The cursor shape at the centre of the screen provides an indication to the operator of whether or not the tracking function is engaged. This augments the cue provided by the reduction in panning and tilting gain. The zoom box provides the operator with a visual cue of the status of the camera focal length. This cue augments the physical feedback from the zoom lever location.

Contrary to the ELVISS design, sensor status overlays have not been included. This information was deemed less essential by the operators for completion of a given mission and therefore was relegated to the screen real estate directly below the corresponding sensor window. In addition, the operator has the ability to tailor the amount of status information to be displayed.

6.3.8 Use and Placement of Moving Map Display Area

The moving map display is used primarily for situational awareness and to relate the camera image to the terrain features in the vicinity. Inclusion of the camera boresight vector and footprint overlays on the moving map are designed to enhance the speed with which the operator can understand the relationship between the aircraft, the camera, and the terrain. Early designs of the AIMS OMI proposed relegating the moving map to the secondary display. However, there were concerns that diverting eyes from the incoming imagery on the primary display to view the moving map would make it more difficult to resume the visual task on the primary display given the physical distance between the two AIMS displays. To minimize this effect, a smaller version of the moving map was included on the primary AIMS display in addition to the larger version on the secondary AIMS display. The moving map on the primary AIMS display was located on the top right corner of the display adjacent to the polar plot due to the commonality with information being displayed.

Map Orientation Considerations

Each of the three possible map, aircraft, and camera orientation options has advantages and disadvantages. The relative merits of each were investigated as part of the ELVISS analysis and are discussed in Reference 17. Essentially, no clear preference was expressed by SMEs for map orientation, although camera up was clearly the least desirable implementation. For this reason, the option to select the desired map orientation is provided through the moving map display controls (see Section 6.3.3).

Map Scaling Considerations

Six different map scales are provided in the AIMS OMI in accordance with Reference 12. The 1:250,000 scale is used by the operator to gather a general idea of the main terrain features that will be encountered in the next several minutes of the search in order to plan effective use of the sensor. The 1:50,000 scale provides detailed information of terrain, buildings, power lines, waterways and roads within several miles of the aircraft, or out to the approximate effective search range of the AIMS system.

Although a 1:10,000 scale is suitable for presentation of the AIMS footprint in a size that is useful to the operator in determining search coverage, an electronic zoom is provided instead. The AIMS operator can select a zoom scale up to 400% through the moving map display controls. This gives the user more flexibility in map area covered and is typical of currently available moving map systems.

6.3.9 Use and Placement of Aircraft and Sensor Status Information

When operators see a contact of interest, they must manipulate the pan and tilt, zoom, focus, range gate, and laser FOV controls to optimize the image and identify the contact. At the same time, the position must be passed to the flight deck in order that the pilot may manoeuvre to keep the contact at the desired range and position in relation to the aircraft. The AIMS operator can designate a waypoint which will appear in the flight deck navigation system to accomplish this; however, there will be a time delay incurred while the pilot interprets and acts upon the waypoint information. To overcome this, the operator will pass a clock angle and distance by voice, to which the pilot can immediately respond. The time saved by passing the information in this manner may be critical to keeping the contact in sight.

The design of the polar plot is intended to provide a quick, easy reference for the operator of where the AIMS system is pointing in reference to the aircraft. The clock angle and range information must be readily available in the desired format, because the operator is busy optimizing the image and can afford little distraction. The polar plot is an ideal method to present a combination of the angle and range information. The clock angle is simple and intuitive to determine at a glance. The range is easily determined within the desired accuracy parameters by comparing the length of the vector to the range ring using the range readout adjacent to the polar plot if the range exceeds the outer range ring. The range rings were sized to represent common terminology for passing distance in this situation. The outer range ring is also sized such that the majority of the searching will be accomplished within that distance from the aircraft, and therefore both range and bearing will normally be available with just a glance at the vector.

For ELVISS, the polar plot range rings were removed due to space limitations with the addition of the second sensor image. However, recommendations from References 18 and 20 suggest the need to maintain an integrated picture of range and bearing. Due to this requirement coupled with the available screen real estate on the larger AIMS display, the ALBEDOS version of the polar plot was re-introduced as part of the AIMS OMI.

The polar plot is located adjacent to the two sensor video windows for easy reference. This location requires minimal deviation of visual attention from the AIMS incoming imagery and is therefore a preferred position for this information.

6.3.10 Use and Placement of Sensor Thumbnails

The sensor thumbnails were placed along the left side of the primary display. Their objective is to provide a snippet of imagery from each AIMS sensor as well as facilitate the operator’s decision with respect to the best sensor to employ given the current environmental conditions. If the intent is to employ these thumbnails to provide continual SA to the operator, their exact size should be further investigated to best support this objective.

6.3.11 Use and Placement of On-Screen Tabs

The bottom right side of the display is reserved for the On-Screen tabs which groups together functionality that will not be used concurrently. It is anticipated that the Video and Still Imagery tab will be accessed more frequently than the remaining tabs and therefore will remain visible for the majority of mission time. As such, this tab occupies the first (or left) position in the sequence of tabs. The remaining tabs may be required to be accessed infrequently based on the mission objectives.

The capability to capture and store still images as well as create video clips addresses the situation where the crew are experiencing difficulties positively identifying a contact thereby ruling it out as a possible object of interest, but may wish to report the sighting post-flight, conduct image enhancement on the still image, e-mail it to an analysis centre, or simply retain an image of the contact as a reminder for later debriefing or analysis. This display element has been purposely kept simple since these functions will be undertaken during search situations whereby workload may be high. To that end, minimal effort is required by the operator to capture still images or create video clips. The ELVISS rapid prototype design accommodated storage of six images; however, SMEs expressed a preference for a larger number to be accommodated. Therefore, the design of the AIMS OMI has not placed a restriction on the storage of still images and video clips.

During the ELVISS design effort, SME comments indicated that it would be advantageous to view stored contacts in the live camera image area in order that they may be presented and viewed in full size. The merit of this must be weighed against the disadvantage of losing the live image for the period in which a stored image is displayed. To compensate, a viewing area has been included in the AIMS OMI design so that thumbnails could be viewed without compromising the incoming live imagery. If image enhancement techniques are implemented, there is a possibility that additional information may be extracted from a stored image. In this situation, the option of presenting the still image at maximum resolution in the sensor windows should be considered.

6.3.12 Use and Placement of Alert and System Status Information

System status information items were organized in two display areas. Status information adjacent to the sensor windows provide an easy reference to critical status information for the sensors and laser illuminator, while the top left corner provides the details on system and equipment status information. The operator will rarely be concerned with camera azimuth and elevation in quantitative terms. In hilly terrain, however, the presentation of range based on the geo-reference system may cause operator confusion in some circumstances which the camera tilt angle information may help to resolve.

The manual range and gain modes and the optical filter setting are rarely used but may all influence image quality. The status of these parameters should be available to the operator in a means that is more readily apparent than simply the position of the switch. They are therefore appropriately included in the system status information located below the respective sensor window.

The operator will rarely require the precise gate depth, since the gate depth will normally be set based on the quality of the visual image and the qualitative feedback from the range gate depth overlay. Situations may be encountered particularly over water or in low contrast conditions in which a suitable image is not available to set the gate for search. In this case, a default gate size for the prevailing conditions may be used which would require a gate depth readout to set accurately. As such a numerical gate range readout has been provided.

The laser illuminator status is available to the operator from the switch positions on the sensor control panel and in the status readouts on the primary display. The redundant laser illuminator readouts on the primary display ensure these indications are not missed by the operator. This is important since there are hazards associated with the active modes of the laser. Amber is used for the related status information when the laser is in an active mode. Colour has been used sparingly on the display, and therefore the use of amber in the system status area for the laser indication is quite eye-catching without detracting from the camera image.

6.4 Control Selection and Layout Rationale

Many options were available for the selection and layout of controls for the AIMS system. Given the nature of the operator population with a strong focus on physical skills, preference was given to a tactile interface. Switches and controls for all the basic functions are therefore implemented using physical devices as opposed to on-screen computer controls or a menu-driven interface. Soft controls were reserved for the low-level functionality that an experienced operator might use. This approach tended to hide the complexity from a less-experienced user as well as minimize the proliferation of controls required to interact with the five AIMS cameras.

In addition to the selection of controls, the layout of controls took into consideration ergonomic factors as defined by relevant military design specifications (MIL-HDBK-759C, MIL-STD-1472F) and civilian computer workstation design standards (CSA-Z412-00, ANSI/HFS 100-1988). Guidelines dictating the location of the AIMS controls include, but are not limited to:

a. Operators should not have to look away from the sensor images to handle controls or to determine the status of the sensor or other functions

b. Primary functions, which are central to the mission, or which are accessed frequently, should be easily and directly controlled by the operators.

c. All critical controls that had to be used while manipulating the sensors were located on the hand controller. Secondary (or supporting) functions that were likely to be carried out in parallel with the steering task were located on a panel that could be easily accessed by the left hand.

d. Secondary functions are less frequently accessed or are less central to the mission and therefore controlled less directly.

e. Controls associated with a given function were grouped together.

f. Control selection was consistent with the type of input (e.g. rotary knobs for continuous settings, toggle switches for discrete settings).[13]

g. Coding was used to facilitate the operator's ability to differentiate controls while minimizing the requirement for visual confirmation.

6.4.1 Use and Placement of the Hand Controller

The hand controller from ELVISS with a proportional displacement thumb controller was retained as the preferred method of control for pan and tilt for the AIMS system. Although, the preference of a rigid hand controller over a displacement hand controller may not be universally accepted. Specifically, a subjective evaluation of controllers determined that the rigid pistol grip with a proportional displacement thumb controller was found to provide the best combination of coarse control, fine control and operator comfort in comparison to a trackball, displacement joystick, rigid force stick, and displacement pistol grip [Reference 17]. It has also been demonstrated that a rigid controller with thumbstick control provides sufficient hand support to function effectively in a high vibration environment. However, an empirical evaluation demonstrated that participants could detect more targets and track targets more consistently with a displacement hand controller in comparison to a displacement thumb controller [Reference 23]. Further studies may be

[13] One exception is the employment of a rotary knob on the sensor control panel to control the FOV settings of a given camera which may be either discrete or continuous. The requirement to support frequent and precise adjustments of the camera FOV setting necessitated the use of a hard control.

required to better assess the advantages and disadvantages of the controller selection for those tasks identified for the AIMS system.

A factor that may contribute to the appropriateness of a given input device is the expectations, experiences, or preferences of the intended user population [Reference 3]. If a given user population has a wealth of experience, familiarity, or acquired skill with a particular type of device, careful consideration needs to be given to replicate the features, functionality, performance, and “feel” to which they are accustomed. In this respect, the Wescam MX-20 employs a rigid handgrip with displacement thumb controller for pan/tilt operations. Since CP-140 sensor operators will be utilizing this system; it may be best to leverage this training and experience with this type of controller for the AIMS design.

Similar to the ELVISS prototype, an aircraft-based option is recommended for pan-tilt operations. With this option, the user pushes the tilt control forward to see more at the bottom of the image, similar to flying an airplane (pull down to go up, and push up to go down).

Consideration was given to accommodating both left-handed and right-handed operators by choosing a central location for the hand controller, or by permitting the controller to be moved such that it was suitable for both left and right hand use. Both these alternatives introduced numerous practical problems including system complexity, the requirement for a symmetrical grip, and the loss of the strong spatial connection between the zoom and range gate controls and their corresponding display elements. The hand controller is therefore located exclusively for right hand use.

In addition to pan and tilt camera control, the following additional controls are located on the hand controller:

a. auto-track selection;

b. auto-slew selection;

c. cloud cover; and

d. target designate.

These controls are included on the hand controller because each of them must be readily available to system operators whose visual attention is fully occupied with the incoming imagery on the primary AIMS display. Most of these controls will be used in conjunction with changes to the camera pan and tilt, and therefore provide a natural functional grouping. ELVISS SMEs found that these other controls could be easily activated without introducing inadvertent inputs into the camera pan and tilt controls.

Auto-track

The auto-track function was included in the ELVISS operator interface due to the difficulties experienced by the ALBEDOS operators with manually tracking the camera in many situations. In particular, ALBEDOS operators experienced great difficulty in manually tracking targets acquired ahead of the helicopter and which then passed beneath, requiring a camera elevation angle close to the vertical. The use of "geo-tracking" as opposed to edge or contrast tracking is proposed as a means to overcome these difficulties. The main advantage of geo-tracking over other tracking methods is that tracking is maintained even if the tracked object disappears from the screen behind trees, foliage or terrain. The main disadvantage of geo-tracking is the reduced accuracy of the tracking solution for moving targets which may become a concern for providing a weapon firing solution. The pan and tilt gain is reduced by a factor of 10 when the auto-track function is activated to assist with fine tuning the geo-track solution. The inclusion of a geo-tracking function will directly contribute to the speed and accuracy of contact identification.

The auto-track selection is allocated to the hand controller trigger switch so that the operator can activate auto tracking without moving the thumb from the manual pan/tilt control. This is required since the operator will be busy steering the turret with the thumb on the manual slew control prior to activating the auto-tracker. The auto-track select is a momentary alternate-action switch. If the auto-track function is off, activation of the trigger switch will select it on; if the auto-track function is on, activation will select it off.

Auto-Slew

The ability of the AIMS system to move quickly to a specific location or a home position was considered desirable by operators of both the ELVISS and ALBEDOS systems. This recommendation is due, in part, to the difficulty of manually panning and tilting the camera for large changes in direction and/or elevation. In particular, verbal camera pointing instructions received from the flight deck can be implemented much more rapidly using auto-slew than they can be manually.

The auto-slew select was the least critical function for inclusion on the hand controller and was positioned for activation by the third or fourth finger. For ELVISS, the auto-slew was activated either following designation of a cursor position on the moving map display, or following a pilot verbal request to point the system directly ahead of the aircraft. The auto-slew select is a momentary switch. Each time the button is activated, the ELVISS camera would slew to a position designated on the moving map display. If no position has been designated on the moving map display, the camera would slew to a default position directly ahead of the aircraft at a 15° depression angle. The implementation of the auto-slew function within ELVISS introduced potential problems as highlighted in Reference 18:

a. If the system is using a low-resolution map, the accuracy of the auto-slew may be further reduced.

b. Operators found it difficult to position the arrow on the moving map with the trackball in the high vibration environment of the helicopter reducing the accuracy of the auto-slew.

c. Designating a location on the moving map with the trackball and activating the auto-slew requires simultaneous interaction with two controls.

d. Not clear how the camera will move to the default position since once an auto-slew position is designated on the moving map with the crosshair, this position will remain until a new position is designated.

The AIMS system will utilize a similar approach for conducting auto-slewing activities. However, additional features will need to be investigated in order to address the aforementioned deficiencies. For instance, to facilitate the concern with accurately designating a target due to the inaccuracies associated with a low-resolution map or vibration, an option to enter geographical coordinates could be provided. In addition, the ability to remove a designated position on the moving map (e.g. via a context-sensitive menu) could be added so that the system can be slewed to the default position.

Cloud Cover

The cloud cover switch was allocated to the hand controller for access with the thumb. With this configuration, the switch can be toggled easily on and off if necessary. It is anticipated that the thumb will be free since the auto-tracking function or mosaic mode will have been previously activated.

Target Designate

The target designate control is located for activation with the thumb. Auto tracking will usually be on at this point so the thumb is no longer needed for manual pan/tilt control. The target designate is used after the operator finds an object of interest. Activating target designate records the location of the object on the moving map and assigns a contact number so as to provide the operator with a reference position to facilitate re-visiting the location at a later time. The position is also passed to the flight deck as a waypoint in order that the pilots may navigate back to the designated location independently if desired. Finally the target designate function stores a snapshot of the video screen contents (within the Video and Still Imagery tab) for use as a prompt to the operator at a later time of what was seen at that location. The visual image may also be subject to image enhancement techniques if desired to assist in identifying the object.

Lessons learned

During a trip to 14 Wing CFB Greenwood, the AIMS project team was able to experience a limited amount of hands-on use with the Wescam MX-20 sensor (see Section 7.4 for more details). The MX-20 joystick includes a thumb controller for adjusting the focus and FOV settings. Moving the thumb controller up and down changes the FOV whereas moving laterally adjusts the focus. This thumb controller is placed adjacent to the pan/tilt thumb controller. While easily accessible, the operator is required to remove his thumb from the pan/tilt control in order to adjust the FOV and/or focus which may not be desirable. In addition, fine adjustments for the focus with this type of controller are difficult to make. As such, the AIMS design has located the FOV and focus controls on the sensor control panel to allow simultaneous operation with pan/tilt operation as well as to better assist with fine adjustments to these parameters.

6.4.2 Use and Placement of Sensor Control Panel

The Sensor Control Panel groups together the discrete and analogue controls for operation of each camera including camera zoom, FOV, gain, focus, manual range and range gate control.

Laser Illuminator Controls

All of the laser illuminator controls (with the exception of secondary functions such as repetition rate and power level) were grouped together for the AIMS system due to their functional relationship. This is different from ELVISS which dispersed these controls across the sensor and bezel control panels as well as the hand controller.

A key driver in the design of the AIMS laser illuminator controls is that the operator should not be forced to look at the console when operating these controls. As such, toggle switches and rotary knobs were selected for the primary laser illuminator controls since they provide kinesthetic feedback of control position. For this reason, the existing two-position pushbutton for ELVISS to support selection of the continuous/gated options was replaced with a toggle switch for the AIMS system. While the ELVISS sliders do provide kinesthetic feedback during operation, they were substituted with rotary knobs based on preferences stated by the operational community. In addition, complementary visual feedback of control actuation (i.e. readouts) is presented on the AIMS primary display to allow the operator to maintain his/her attention on the screen.

For ELVISS, the laser passive/active wide FOV/active narrow FOV selection is a three-position switch located above and slightly left of the thumb pan/tilt controller. With the switch in the aft position the laser illuminator is passive, (i.e. not transmitting). With the switch in the middle position the laser is transmitting in the wide FOV, and with the switch in the forward position the laser beam is transmitting in the narrow FOV. This sequence represents the normal order in which the laser functions are used (i.e. wide FOV to search for objects and narrow FOV to identify objects). Although the three position switch would reduce memory load and require less movement of the thumb while operating the joystick, there are opinions that this functionality correlates better as two separate functions. This would also avoid inadvertently turning the laser illuminator off when adjusting the divergence. To that end, this control was split up into two toggle switches (i.e. divergence and mode) and re-located to the sensor control panel on the AIMS console.

Divergence will often be changed during a search and in conjunction with changes to where the sensors are pointing. For these reasons, the divergence toggle switch was located for convenient access and to be operated by the left hand in conjunction with manual pan/tilt adjustments by the right hand. In addition, typically the pulse width is adjusted every time the divergence is changed. Since these controls are linked they have been located in close proximity to one another on the sensor control panel.

The manual range/range gate control for the AIMS system is allocated to the left hand for actuation. The preferred type of manual range/range gate control is not well suited to inclusion on the hand controller, and the range gate control must be available for use simultaneously with pan and tilt in poor weather. Also, the hand controller must be kept relatively simple to operate for the typical AIMS operator. In addition, these controls require fine adjustments which are better suited to hard controls instead of actuation through the touchscreen suite of controls. Since these functions require frequent interaction, they have been located in the bottom row of controls in closer proximity to the seated operator.

During the ALBEDOS field trial, the operators were rarely able to optimize the gate range and gate width for the search task. Similarly, the ELVISS operators tended to focus on the image and often failed to make use of the available capabilities of the system. The inclusion of an automatic mode for the range control in the AIMS system should help alleviate this problem.

Camera Controls

Similar to the laser illuminator controls, the camera controls are allocated to the left hand for operation because they will frequently be used simultaneously with the manual pan and tilt controls on the hand controller.

For ELVISS, hard controls for operation of both cameras were allocated space on the sensor control panel. Given that ELVISS only contained two cameras, the number of camera controls was kept to a manageable set. Although, the operators did experience difficulties locating controls for a given camera or illuminator control task. This becomes increasingly problematic when the operator is required to remain focused on the incoming imagery. This issue becomes further compounded with the AIMS system which includes five cameras with a number of adjustable parameters. Possible options for the camera controls on the AIMS sensor control panel include:

a. **Soft controls for each sensor.** This design solution saves real estate and avoids confusion with selecting the correct controls. Although, kinesthetic feedback is not as good as hard controls which may prove critical for making fine adjustments to a given camera.

b. **Dedicated hard controls for each sensor.** Since there are five cameras, there would be a considerable number of controls which takes up space and may introduce complexity to the console design.

c. **Re-usable hard controls.** Given the overlap in functionality across the individual sensors, hard controls could be reusable whereby their activation would be tied to the selection of the primary sensor.

For the AIMS console, the design decision was to incorporate a combination of soft and hard controls to accommodate the advantages of both options. In this manner, hard controls are provided for those functions that require a combination of quick and frequent access as well as precise adjustments. For the AIMS system, the focus, FOV, and gain settings have been identified as functions complying with these requirements. The remaining secondary camera controls are reserved for the touchscreen.

To maintain a spatial mapping between the sensor windows on the primary AIMS display and the sensor control panel, the camera controls are clustered into two groups. The grouping farther away from the operator (or higher on the sensor control panel) controls the parameters for the camera displayed in the higher sensor window. Whereas, manipulating the camera controls that are closer to the operator (or lower on the sensor control panel) adjust the settings for the camera in the lower sensor window. For each grouping of controls, the zoom and focus controls are co-located since the operator is likely to adjust the focus after zooming in or out. As such, this configuration allows the operator to shift between controls while maintaining visual attention on the screen for feedback. The controls are discriminated by size to support their operation without having to look at the console.

Depending on the individual AIMS sensor, the FOV settings may either be discrete or continuous values (see Table 2). Despite this variability in FOV settings, the FOV controls were allocated rotary knobs due to their frequent adjustment during a typical mission. During the ELVISS field trials, the operators found it time consuming to zoom out in order to resume a search. They stated a preference for an ability to quickly zoom out. As such, a ‘Zoom Out’ button was added on the touchscreen for sensors possessing a continuous FOV setting in order to bypass the need to sequentially increase this setting. Pressing the button again could also cause the sensor to return to the previous FOV setting. The "Zoom Out" button is not required for sensors with discrete FOV settings since the operator can simply select the largest FOV setting as a means to quickly zoom out.

System Power Controls

These controls are grouped separately from the laser illuminator and sensor controls. These controls are used infrequently in flight, but must be readily available when required.

6.4.3 Use and Placement of Moving Map Controls

Those controls associated with the large moving map on the dedicated display are relegated to touchscreen controls since they are neither accessed frequently nor require precise adjustments. This functionality will be typically accessed at the start of the mission in order to configure the display in accordance with any operational requirements. In the event that the dialog boxes must be accessed during operation, semi-transparent overlays were designed to minimize obstructing the moving map information.

6.4.4 Use and Placement of Cursor Control Device

The cursor control device is centrally located within comfortable reach of the operator. Sufficient work surface is provided between the operator and the cursor control device to function as an armrest for the operator and prevent fatigue. Most AIMS cursor usage occurs in the moving map screen area and stored image area requiring short, accurate movements. In an airborne environment subject to vibration and turbulence this requirement is ideally met using a trackball. A trackball offers precise control for positioning the cursor while being relatively insensitive to vibration effects.

A Position Designate button is located beside the trackball. The Position Designate button functions with the cursor position to select a location to which the camera may be automatically slewed. This control is included with the trackball because the function is required in conjunction with cursor movement. The trackball location therefore provides a natural functional grouping.

6.4.5 Use and Placement of the Keyboard

The majority of the AIMS interface is designed for an interaction that supports direct manipulation of objects on the screen. Although, there are tasks that present themselves periodically during the missions that require entry of alphanumeric data (e.g. configuring automatic scan settings). As such, the keyboard needs to be readily accessible for completion of these tasks and stowed away during the rest of mission to free up desktop surfaces for electronic support measures (ESM) laptops, paperwork, etc. To address this requirement, the keyboard will be installed directly in front of the operator with a hinged cover to hide the keyboard when not in use.

7. Issues for Consideration

7.1 General

During the generation of the AIMS design concepts, as presented in this report, several issues were raised requiring further exploration. Collectively, these issues for consideration are presented in this section as areas of investigation or research to support future instantiations of the AIMS system.

7.2 Mosaic Mode of Operation

The mosaic mode of operation is a new concept under exploration by the AIMS project office. The introduction of this mode of operation is aimed at facilitating search tasks by compensating for traditional problems associated with conducting a search through an EO/IR system with a narrow field of view. Preliminary exploration into the mosaic mode and its instantiation into an OMI for inclusion in the AIMS design was undertaken. It is anticipated that enabling the mosaic mode would change the primary AIMS display in order to maximize screen real estate for viewing the stitched imagery. Figure 35 illustrates replacing the sensor thumbnails, sensor windows, and the sensor status readouts to free up screen real estate for the incoming stitched imagery.

Figure 35. *Primary AIMS Display – Mosaic Mode*

Possible controls for configuring and activating the mosaic mode settings were presented as part of the sensor control panel (Figure 26). The AIMS OMI will have to be further refined upon gaining a better understanding of the implementation of the mosaic mode.

7.3 Automatic Scan Mode of Operation

The ELVISS system introduced an automatic scanning function in an attempt to reduce operator workload. This mode of operation was limited in functionality as the operator may select from three scan rates/speeds and three sector sizes. The scan rates are 1.5, 3, and 4.5 degrees per second. The sector size is selectable in three sizes: 30°, 60° and 90°. The automatic scanning functions were located between the laser and map control sections. To start scanning the operator would select the desired scan rate and sector size, and then activate the scanning through the scan selection. To stop the scanning, the operator would deselect the scan function, select manual tracking, or activate the automatic tracking function.

The sector was defined using the current turret position as the centre of the sector. As an example, if the turret was pointing at the two o'clock position and the operator selected the 60° size, the turret would scan plus and minus 30° from the current turret position, or between 30° and 90°.

A similar implementation should be investigated for implementation in the AIMS system. It is anticipated that controls for activating and configuring the automatic scan mode would be resident on the touchscreen portion of the sensor control panel.

7.4 Current MX-20 operation

A trip to CFB Greenwood in April 2006 provided a first-hand look at the operator interactions with the Wescam MX-20 system. Figure 36 and Figure 37 depict the installation of the MX-20 in a CP-140 mock-up that is employed for training EO/IR operators. Witnessing the conduct of the training illustrated inherent functionality that was not considered during the design of the AIMS OMI. This functionality was resident in both the control panel as well as on-screen menus that are accessed via the buttons located below the monitor. For instance, the operator is required to frequently re-calibrate the IR image using a toggle switch on the sensor control panel.

For completeness, this functionality should be considered for inclusion into the AIMS OMI design. To adequately address this issue, a better understanding of the MX-20 standard operating instructions is required.

Figure 36. Wescam MX-20 Primary Display and Hand Controller

Figure 37. Wescam MX-20 Control Panel

7.5 Multiple Operator Console

The notion of an AIMS operator console compatible for two person operation was introduced in Section 5.1. With this notion, there are several design issues that require further examination to support this concept.

One issue is determining the set of controls for duplication and placement of shared controls. Naturally, there would only be one set of power controls for the AIMS system. However, controls resident on the sensor control panel would need to be duplicated in order to facilitate operation of the payload from both positions. There is a need to minimize conflicting operations through measures including explicit means such as locks to prevent operation by a given operator when it is not their responsibility to control the sensor. More implicit measures such as standard operating procedures may resolve issues of this nature.

Further investigation is also required to maximize the presentation of information on each operator's display. Would each operator have a customized view to match his roles or responsibilities or would the screens be duplicated? Answers to these questions would naturally flow out of a better understanding of the division of labour that is anticipated for two operators collaborating with the AIMS system.

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Annex A Mapping Tasks to Interface

To demonstrate compliance with the results from the task analysis, this appendix provides traceability between the tasks and their instantiation within the proposed AIMS OMI design.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
Pre- and Post-Flight Tasks		
Select System AC Power On	Upon verifying the switch settings are in their correct position, the operator applies AC power to the AIMS system by activating the System AC Power On function on the operator control panel. The operator visually verifies that the display is updated as expected, and the System AC Power On indicator is illuminated. The power switch must be guarded against accidental activation. During cold start up, there is a 10 min warm-up time. In these situations, the operator will be presented with feedback indicated the delay in the warm-up process.	• AC power switch with LED is provided as part of the Sensor Control Panel.
Select System DC Power On	The operator applies DC power to the AIMS system by activating the System DC Power On function. The operator visually verifies that the System DC Power On indicator is illuminated. The power switch must be guarded against accidental activation.	• AC power switch with LED is provided as part of the Sensor Control Panel.
Verify Switch Settings	The operator visually inspects the AIMS control panel to verify that all switch settings are in the correct position. During the performance of the task, the operator makes a decision as to whether any switch positions need to be changed. This activity would normally be completed prior to applying power to the system, although it could also be conducted at other times (e.g. immediately prior to enabling the laser illuminator). The operator may refer to Standard Operating Procedures or checklists during the performance of this task.	• System power switches (AC and DC) are located on the Sensor Control Panel • LEDs adjacent to the power toggle switches and readouts in the system status section of the primary display depict the system power settings
Select System Status Information	In preparation for checking the current status of the AIMS system, the operator selects the function which causes system status information to be displayed. The operator visually verifies that the information is displayed as expected. Presentation of the system status information may be done automatically to the operator upon power up. More detailed system status information may also be accessible to support a technician.	• Status information for each sensor is presented on readouts adjacent to the sensor windows and on the Sensor Status tab
Check Parameter Settings	The operator visually inspects all relevant system parameter settings for consistency with the mission objectives. During the performance of the task, the operator makes a decision as to	• Status information for each sensor is presented on readouts adjacent to the sensor windows and on the Sensor Status tab

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	whether any parameter settings need to be changed. This decision is based primarily on the anticipated environmental conditions and the likelihood of the search object being a cooperative target. Since the operator is able to make the changes while viewing the system status information, there is no need to make notes for future reference.	
Adjust Parameter Settings	Having made a decision on the system parameter settings that need to be changed, the operator makes the adjustments via the operator control panel. This task is accomplished while also viewing the system status information. The operator visually verifies that the parameter is adjusted as desired.	• The sensor control panel, hand controllers, and soft controls on the display allow adjustment of system parameter settings • Feedback on parameter adjustments are presented on the primary AIMS display
Note System Ready Indications	The operator verifies that the AIMS system is ready for operation. This includes confirming that power is applied and, if applicable, the laser illuminator is armed. The operator makes a mental note of any actions required to make the system ready for use.	• LEDs adjacent to the power and laser illuminator toggle switches and readouts in the system status section of the primary display depict the system power and laser mode settings
Conduct System Functional Checks	The operator conducts a series of functional checks to ensure the system is operational and configured as required to accomplish mission objectives. This activity includes verifying proper operation of functions such as Pan, Tilt, Focus, Zoom, Filter and Gain (contrast) as well as conducting calibration checks. While activating each function, the operator verifies that the display imagery and system status indicators function as anticipated. The operator normally refers to a checklist during the performance of this task. Self-initiated built-in tests may also be conducted by the system with results accessible to the operator/maintainer.	• The sensor control panel, hand controllers, and soft controls on the display allow adjustment of system parameter settings • Further investigation is required to determine OMI requirements for calibration checks and built-in tests. The Maintenance tab has been reserved for inclusion of these tests.
Confirm appropriate graphics available	The operator views display and confirms that all required graphics are displayed. If required graphics are not there or if non-required graphics are visible the operator will select the appropriate graphics for display.	• Does not impose requirements on the AIMS OMI design
Note IR Image Available	Operator confirms that the IR image is available after between 8 to 10 minutes cool down. The AIMS system remains operable while the IR system is cooling down.	• Does not impose requirements on the AIMS OMI design

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Check Video and Audio Recording	The operator conducts a series of checks to ensure the AIMS video and audio recorder is operational and functioning as expected. This activity consists of recording a short video segment, inserting a test voice annotation, and replaying the tape to ensure proper operation of the recording and playback functions (including time code information). The operator verifies proper operation both visually and aurally, making either mental or written notes of deficiencies as required for future reference. The operator normally refers to a checklist during the performance of this task.	• The Single Frame and Video Imagery tab on the primary AIMS display provides access to controls to conduct these pre- and post-flight checks
Deselect System Status Information	Having verified that the system is configured as desired, the operator de-selects the system status information from the display. The operator visually verifies that the status information is no longer displayed.	• System status information is presented within the on-screen tabs located in the bottom right corner of the primary AIMS display
Select System Power Off	The operator removes both AC and DC power from the AIMS system by activating the System Power Off function on the operator control panel. The operator visually verifies that the display is cleared as expected, and the System Power On indicator is no longer illuminated.	• System power switches (AC and DC) are located on the Sensor Control Panel • LEDs adjacent to the power toggle switches and readouts in the system status section of the primary display depict the system power settings
Illuminator Control Tasks		
Illuminator Status Controls		
Select Laser Active	The operator selects the Laser Active mode on the control panel, which causes the illuminator to be operational. The operator verifies that the illuminator is operating as anticipated.	• A toggle switch for setting the laser mode (active or passive) is located on the sensor control panel. An LED adjacent to the switch is illuminated when the mode is set to Active
Select Laser Passive	The operator selects the Laser Passive mode on the control panel, which causes the illuminator to cease operating. In this mode, the Gate and Range functions have no affect on the video image. The operator verifies that the illuminator is no longer operating, and that the video imagery is updated as expected.	• A toggle switch for setting the laser mode (active or passive) is located on the sensor control panel. An LED adjacent to the switch is illuminated when the mode is set to Active • Associated illuminator functions (gate and range) are not

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
		operational when the mode is set to Passive
Select Laser Active Sub-mode – Continuous	If the operator selects the Laser Active mode on the control panel, the operator then selects the Continuous sub-mode which does not invoke the active gated functionality. The active gated functionality will not be accessible in this sub-mode. This sub-mode may be used for clear nights without any cloud, rain, snow, etc.	• A toggle switch for setting the laser sub-mode (continuous or gated) is located on the sensor control panel. • Associated illuminator functions (gate and range) are not operational when the mode is set to Continuous
Select Laser Active Sub-mode – Gated	If the operator selects the Laser Active mode on the control panel, the operator then selects the Gated sub-mode which causes the illuminator to operate in synchronization with the camera gating signals. The active gated functionality will be accessible in this sub-mode.	• A toggle switch for setting the laser sub-mode (continuous or gated) is located on the Sensor Control Panel. • Associated illuminator functions (gate and range) are not operational when the mode is set to Continuous
Arm Laser Illuminator	The operator arms the laser illuminator by selecting the Laser Arm function on the operator control panel. This enables the laser illuminator for operation. The operator visually verifies that the Laser Armed indicator is illuminated. The design of the operator control panel incorporates safeguards to prevent inadvertent arming of the laser illuminator system.	• A toggle switch to arm/disarm the laser is located on the Sensor Control Panel. An LED adjacent to the switch is illuminated when the laser is armed.
De-Arm Laser Illuminator	The operator de-arms the laser illuminator by selecting the Laser Safe function on the operator control panel. This configures the system in a safe mode to prevent external illumination. The operator visually verifies that the Laser Armed indicator is no longer illuminated.	• A toggle switch to arm/disarm the laser is located on the Sensor Control Panel. An LED adjacent to the switch is illuminated when the laser is armed.
Note Illuminator Status Indicator	The operator visually checks the status of the laser illuminator. This task is conducted periodically throughout the mission for situational awareness and to confirm the status of the arming and active/passive functions. The operator makes a decision as to whether any action is required to change the status of the laser illuminator.	• An LED adjacent to the switch is illuminated when the laser is armed. The System Status portion of the primary AIMS display also depicts the illuminator status.
Adjust Illuminator Power Level	The operator selects the power level for the laser illuminator as required for the current mission objectives.	• A rotary knob for continuous adjustment of the laser power is provided on the Sensor Control Panel.

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		• A readout of the power level is provided in the sensor window status region and on the sensor status tab of the primary AIMS display.
Note Illuminator Power Level	The operator visually checks the power level of the laser illuminator. This task is conducted periodically throughout the mission. The operator makes a decision as to whether any action is required to change the power level of the laser illuminator.	• A readout of the power level is provided in the sensor window status region and on the sensor status tab of the primary AIMS display.
Range Controls		
Select Automatic Range Control	The operator activates the Automatic Range Control Mode by selecting Auto-Range on the control panel. The operator verifies that the manual range control function is no longer available, and that the Illumination Range updates in response to changes in the distance to the target. The Auto-Range control function is only available when the laser illuminator is in the Active Mode.	• A toggle switch for setting the Automatic Range Control Mode (manual or automatic) is located on the Sensor Control Panel.
Select Manual Range Control	The operator activates the Manual Range Control Mode by selecting Manual Range on the control panel. The operator verifies that the manual range control function becomes operable, and that the Illumination Range updates in response to adjustments to it. The Manual Range control function is only available when the laser illuminator is in the Active Mode.	• A toggle switch for setting the Automatic Range Control Mode (manual or automatic) is located on the Sensor Control Panel.
Note Illuminator Range	The operator visually checks the Illuminator Range to ensure it is as anticipated. This task is performed periodically while in Laser Active Mode, with either automatic or manual range control selected. The operator mentally evaluates the illumination range for consistency with the display imagery, and makes a decision as to whether the current configuration for range control is appropriate.	• A readout of the range setting is provided as an overlay on the primary sensor window and on the sensor status tab of the primary AIMS display.
Adjust Range Manually	The operator uses the manual range control function on the control panel to adjust the range of the camera gate (i.e. the slant range to the closest point of the area to be illuminated).While performing this task, the operator refers to the camera imagery to obtain estimates of the range to the target. The operator verifies that the range	• A rotary knob for continuous adjustment of the range setting is provided on the Sensor Control Panel. • A readout of the range setting is provided in the sensor window

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	setting and the video imagery are updated as expected. The operator may refer to Standard Operating Procedures for guidance in determining the optimum value for specific missions, flight profiles and environmental conditions. This task may be performed in either Laser Active or Passive Modes, although there will be no effect on the imagery in the Passive Mode.	status region and on the sensor status tab of the primary AIMS display.
Range Gate Depth Controls		
Note Range Gate Depth	The operator visually checks the current setting for the camera gate depth, and makes a decision as to whether the current value is appropriate for the current mission. The operator may refer to Standard Operating Procedures for guidance in determining the optimum value for specific missions, flight profiles and environmental conditions. This task may be performed in either Laser Active or Passive Modes.	• A readout of the range gate depth is provided as an overlay on the primary sensor window and on the sensor status tab of the primary AIMS display.
Adjust Range Gate Depth Manually	The operator uses the Gate Depth function on the control panel to adjust the camera gate depth. The operator verifies that the current gate depth setting and the video imagery are updated as expected. The operator may refer to Standard Operating Procedures for guidance in determining the optimum value for specific missions, flight profiles and environmental conditions. This task may be performed in either Laser Active or Passive Modes, although there will be no effect on the imagery in the Passive Mode.	• A rotary knob for continuous adjustment of the range gate depth is provided on the Sensor Control Panel. • A readout of the range gate depth is provided in the sensor window status region and on the sensor status tab of the primary AIMS display.
Illuminator Divergence Controls		
Select Illuminator Divergence	The operator selects either Wide or Narrow Divergence for the laser illuminator as required for the current mission objectives. This is accomplished by activating the Divergence Select function and verifying that the correct selection is implemented.	• A toggle switch for setting the illuminator divergence (wide or narrow) is located on the Sensor Control Panel.
Note Illuminator Divergence	The operator visually checks whether the laser illuminator is selected to Wide or Narrow Divergence. This task is conducted periodically throughout the mission to ensure quality imagery is obtained. The operator makes a decision as to whether the current	• The selection of illuminator divergence setting is apparent based on the position of the toggle switch/

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	selection is correct.	• A readout of the laser illuminator divergence is also provided in the sensor window status region and on the sensor status tab of the primary AIMS display.
Pulse Width Controls		
Select Pulse Width	The operator selects the pulse width for the laser illuminator as required for the current mission objectives. This is accomplished by activating the Pulse Width function and verifying that the correct selection is implemented.	• Touchscreen buttons are provided for continuous adjustment of the pulse width for the laser illuminator.
Note Pulse Width	The operator visually checks the pulse width of the laser illuminator. This task is conducted periodically throughout the mission to ensure quality imagery is obtained. The operator makes a decision as to whether the current selection is correct.	• A readout of the laser illuminator pulse width is provided in the sensor window status region and on the sensor status tab of the primary AIMS display.
Repetition Rate Controls		
Select Repetition Rate	The operator selects the repetition rate for the laser illuminator as required for the current mission objectives. This is accomplished by activating the Repetition Rate function and verifying that the correct selection is implemented.	• Touchscreen buttons for continuous adjustment of the repetition rate for the laser illuminator are provided on the Sensor Control Panel.
Note Repetition Rate	The operator visually checks the repetition rate of the laser illuminator. This task is conducted periodically throughout the mission to ensure quality imagery is obtained. The operator makes a decision as to whether the current selection is correct.	• A readout of the laser illuminator repetition rate is provided in the sensor window status region and on the sensor status tab of the primary AIMS display.
Camera and Lens Control Tasks		
Select Primary Sensor	The primary display area shows multiple sensor windows simultaneously. The operator chooses which is to be considered primary. The sensor image window for the primary sensor is given visual priority. The primary sensor setting is also critical to common	• Touchscreen buttons for selection of the primary sensor are provided on the Sensor Control Panel. • The primary sensor window is highlighted with a green border

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	functions, such as auto-track. When the auto-track function is selected, the auto-track on/off command is sent to the primary sensor. Selection of the primary sensor depends on factors such as the environmental conditions and the target type.	and overlays are displayed on the incoming imagery. • Common functions will be sent to the primary sensor.
Focus Controls		
Observe Image Out-Of-Focus	While monitoring the display, the operator observes that the image is out of focus. A decision is made that the quality of the image can be improved.	• To assess the impact of changing the setting, incoming imagery is presented within the operator’s primary field of view.
Initiate Automatic Focus Control	The operator activates the Automatic Focus Control Mode by selecting Auto-Focus on the control panel. The operator monitors the quality of the display image during the performance of the task to obtain the optimum setting. The operate may need to manually fine-tune the focus in order to achieve an image that is as clear and sharp as possible.	• Touchscreen buttons for setting the focus control mode (automatic or manual) of the primary and secondary sensors are provided on the Senor Control Panel. • Rotary knobs for fine-tuning the focus of the primary and secondary sensors are provided on the Sensor Control Panel. • To assess the impact of changing the setting, incoming imagery is presented within the operator’s primary field of view.
Deactivate Automatic Focus Control	The operator de-selects the Auto-Focus function on the control panel to deactivate it.	• Touchscreen buttons for setting the focus control mode (automatic or manual) of the primary and secondary sensors are provided on the Senor Control Panel.
Adjust Focus Manually	The operator adjusts the display focus to achieve an image that is as clear and sharp as possible. This is accomplished by manually adjusting the Focus control on the operator control panel. The operator monitors the quality of the display image during the performance of the task to obtain the optimum setting.	• Rotary knobs for manually adjusting the focus of the primary and secondary sensors are provided on the Sensor Control Panel. • To assess the impact of changing the setting, incoming imagery is presented within the operator’s primary field of view.
FOV Controls		
Note Additional Object Detail Required	While visually monitoring display imagery, the operator observes that additional detail is required to clarify the characteristics of the return from a particular geographical position. This activity is	• To assess the impact of changing the setting, incoming imagery is presented within the operator’s primary field of view.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	normally associated with the task of classifying or identifying a particular contact. A decision is made as to how best to obtain the additional detail.	
Note Larger Camera FOV Required	While visually monitoring display imagery, the operator observes that a wider camera field-of-view is required to accomplish mission objectives. This activity is normally associated with the function of conducting a wide-area search. The operator assesses the impact that a wider FOV would have on the ability to detect the object of the search, and makes a decision on the optimum FOV.	• To assess the impact of changing the setting, incoming imagery is presented within the operator's primary field of view.
Adjust FOV/Zoom	The operator uses the Zoom control to adjust the magnification factor up or down to obtain the optimum field-of-view (FOV) and image resolution to accomplish specific mission objectives (e.g. to conduct a large-area search or to obtain details on an identified object). The operator monitors the imagery during the performance of this task, mentally evaluating the relative merits of the imagery as the zoom factor is adjusted. A decision is made on the optimum zoom factor to best achieve current mission objectives. The operator may refer to Standard Operating Procedures for guidance in configuring the camera for different missions, flight profiles and environmental conditions. When zooming in, the pan/tilt sensitivity are automatically adjusted to support operate of these functions.	• Touchscreen buttons for adjusting the FOV/zoom of the primary and secondary sensors are provided on the Senor Control Panel. The touchscreen buttons will vary depending on whether the sensor requires continuous or discrete adjustments to the FOV/zoom setting.
Note FOV Status Indication	The operator notes the current FOV setting for a given camera by reading the text information on the display.	• A readout of the FOV setting is provided in the sensor window status region of the primary AIMS display.
Gain Controls		
Select Automatic Gain Control	The operator configures the camera to automatically adjust the gain (i.e. contrast level) of the camera in response to existing environmental conditions, aircraft altitude and speed, and other camera settings (i.e. lens extender setting, zoom factor, etc.). This function will also automatically adjust the laser illuminator parameters (i.e. power level, pulse width, divergence) when the laser is set to Active Mode. This is accomplished by selecting Auto-Gain on the control panel. The operator evaluates the quality of the imagery and makes a decision as to whether mission objectives	• Touchscreen buttons for setting the gain control mode (automatic or manual) of the primary and secondary sensors are provided on the Senor Control Panel.

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	could be better accomplished with manual control.	
Select Manual Gain Control	The operator configures the camera for manual gain control (i.e. contrast level). This is accomplished by selecting Manual Gain on the control panel.	• Touchscreen buttons for setting the gain control mode (automatic or manual) of the primary and secondary sensors are provided on the Senor Control Panel.
Adjust Gain Manually	The operator uses the Gain function on the control panel to adjust the image contrast for maximum effectiveness. The operator monitors the display visually to verify that the contrast changes in response to control adjustments, and to achieve the optimum setting. The operator evaluates the quality of the imagery and makes a decision as to whether improved performance could be obtained with the Auto-Gain setting.	• Rotary knobs for manually adjusting the gain of the primary and secondary sensors are provided on the Sensor Control Panel. • To assess the impact of changing the setting, incoming imagery is presented within the operator's primary field of view.
Note Gain Status Indicator	The operator periodically checks the Gain Status Indicator to verify if the system is configured for automatic or manual gain control. A decision is made as to whether a change is required.	• A readout of the gain is provided in the sensor window status region and on the sensor status tab of the primary AIMS display.
Electronic Zoom		
Activate Electronic Zoom	The operator selects the Electronic Zoom function on the control panel to activate the zoom to improve the quality of the imagery. The operator mentally compares the quality of the "before" and "after" images, and makes a decision as to which configuration offers the best performance with respect to mission objectives.	• Touchscreen buttons for setting the electronic zoom mode (on or off) of the IR sensor are provided on the Senor Control Panel. • To assess the impact of changing the setting, incoming imagery is presented within the operator's primary field of view.
Deactivate Electronic Zoom	The operator de-selects the Electronic Zoom function on the control panel to deactivate the zoom.	• Touchscreen buttons for setting the electronic zoom mode (on or off) of the IR sensor are provided on the Senor Control Panel.
Set Magnification Factor	The operator adjusts the magnification factor between 1x and 10x as required for the current mission objectives.	• Touchscreen buttons for setting the electronic zoom magnification factor for the IR sensor are provided on the Senor Control Panel.
Note Electronic Zoom Indicator	The operator notes the current electronic zoom setting for a given camera by reading the text information on the display.	• A readout of the electronic zoom is provided in the sensor window status region and on the sensor status tab of the primary

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
		AIMS display.
IR Polarity Controls		
Select IR Polarity	The operator toggles the IR camera polarity and confirms a reversal in gray scale of the IR scene.	• Touchscreen buttons for setting the IR camera polarity (white hot or black hot) of the IR sensor are provided on the Senor Control Panel. • To assess the impact of changing the setting, incoming imagery is presented within the operator's primary field of view.
Note IR Image Polarity	The operator notes the current IR polarity setting for the IR camera by reading the text information on the display.	• A readout of the IR image polarity is provided in the sensor window status region and on the sensor status tab of the primary AIMS display.
Filter Controls		
Select Filter On	The operator selects the Filter On function on the control panel to activate the optical noise filter to improve the quality of the imagery. The operator mentally compares the quality of the "before" and "after" images, and makes a decision as to which configuration offers the best performance with respect to mission objectives.	• Touchscreen buttons for setting the filter mode (on and off) of the primary and secondary sensors are provided on the Sensor Control Panel. • To assess the impact of changing the setting, incoming imagery is presented within the operator's primary field of view.
Select Filter Off	The operator selects the Filter Off function on the control panel to remove the optical noise filter. The operator mentally compares the quality of the "before" and "after" images, and makes a decision as to which configuration offers the best performance with respect to mission objectives.	• Touchscreen buttons for setting the filter mode (on and off) of the primary and secondary sensors are provided on the Sensor Control Panel. • To assess the impact of changing the setting, incoming imagery is presented within the operator's primary field of view.
Note Filter Status Indicator	The operator periodically checks the Filter Status Indicator to verify if optical noise filter is engaged or not. A decision is made as to whether a change is required.	• A readout of the filter status is provided in the sensor window status region and on the sensor status tab of the primary AIMS display.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
Iris Setting Controls		
Iris Setting Width	The operator selects the iris setting for a camera as required for the current mission objectives. This is accomplished by activating the Iris Setting function and verifying that the correct selection is implemented.	• Touchscreen buttons for continuous adjustment of the iris setting are provided on the Sensor Control Panel.
Note Iris Setting	The operator visually checks the iris setting of the camera. This task is conducted periodically throughout the mission to ensure quality imagery is obtained. The operator makes a decision as to whether the current selection is correct.	• A readout of the iris setting is provided in the sensor window status region and on the sensor status tab of the primary AIMS display.
Steering Control Tasks		
Vehicle Slave Mode Controls		
Select Vehicle Slave Set	The operator defines a camera position relative to the aircraft (i.e. pan angle) by selecting the Slave Set function on the control panel. The operator verifies that the Slave Set entry has been accepted by the system.	• Requires further investigation
Select Vehicle Slave Mode	The operator activates the vehicle-slaved mode of operation. This is accomplished by activating the Slave On function on the operator control panel. In this mode the camera returns to the slaved position anytime that joystick pressure is released. The operator verifies that the camera is slewed to the Slave Set position when joystick pressure is released, and that the Slave Status Indicator reflects the vehicle-slaved mode.	• Requires further investigation
De-Select Vehicle Slave Mode	The operator configures the camera in an unslaved mode by activating the Slave Off function on the operator control panel. The operator verifies that the Slave Status Indicator reflects the unslaved mode, and that the pan and tilt controls function as anticipated.	• Requires further investigation
Note Vehicle Slave Status	The operator periodically glances at the Slave Status Indicator to	• Requires further investigation

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
Indicator	confirm the current camera positioning mode. A decision is made as to whether there is a need to initiate a change to the system.	
Modes of Operation		
Manual Mode Controls		
Adjust Pan/Tilt Sensitivity	The operator adjusts pan and/or tilt sensitivity by activating the Pan/Tilt Sensitivity functions on the maintenance control panel. The default enables the operator to adjust both pan and tilt simultaneously, but the option also exists to adjust them independently.	• Maintenance tab has been included in the AIMS OMI to support functionality of this nature. More investigation is required to design controls residing on this tab.
Adjust Pan Angle	The operator activates the Camera Panning function on the control panel to adjust the azimuth angle of the camera. This task is required either to concentrate on a particular geographical position or to conduct a systematic search of an area. During the performance of this task, the operator continuously monitors the camera imagery to ensure the desired coverage is obtained. The operator also monitors the bearing of the camera relative to either True North or aircraft heading. This task is normally performed while also adjusting the tilt angle.	• An omi-directional chinese hat for adjusting the azimuth angle of the camera is provided on the Hand Controller. • To assess the impact of changing the setting, incoming imagery is presented within the operator's primary field of view. • A polar plot, adjacent to the incoming imagery presents the camera angle relative to True North and aircraft heading.
Adjust Tilt Angle	The operator activates the Camera Tilt function on the control panel to adjust the elevation angle of the camera. This task is required either to concentrate on a particular geographical position or to conduct a systematic search of an area. During the performance of this task, the operator continuously monitors the camera imagery to ensure the desired coverage is obtained. The operator also monitors camera elevation relative to the horizon. This task is normally performed while also adjusting the camera panning angle.	• An omi-directional chinese hat for adjusting the elevation angle of the camera is provided on the Hand Controller. • To assess the impact of changing the setting, incoming imagery is presented within the operator's primary field of view.
Slew Turret to Centre Contact on Display	The operator initiates the slewing of the camera to a specific contact or geographical position on the display. This is accomplished by designating the contact or position and activating the Slew-to-Contact function on the control panel. The operator monitors the imagery and the camera position to verify that the camera is slewed	• An auto-slew button is provided on the Hand Controller. Pressing the button will slew the sensor to a pre-defined location on the moving map.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	to the desired position.	
Auto-Scan Controls		
Initiate Automatic Scanning Mode	The operator initiates automatic camera scanning by selecting the Auto-Scan function on the control panel and selecting a pre-defined scan pattern. Selection of this function also provides the operator with a recommended aircraft groundspeed to ensure 100% coverage. The operator monitors the moving map display to ensure the search is providing the desired coverage.	• Touchscreen buttons for initiating/terminating the Auto-Scan function are provided on the Sensor Control Panel. • Touchscreen buttons are also provided to assist the operator with optimizing the scan pattern based on aircraft course, speed, and altitude.
Terminate Automatic Scanning Mode	The operator terminates automatic camera scanning by de-selecting the Auto-Scan function on the control panel. The operator verifies that the system status indicator is updated to reflect the manual steering mode, and the camera angle no longer changes automatically. The operator also verifies that the Pan and Tilt functions are available and functional.	• Touchscreen buttons for initiating/terminating the Auto-Scan function are provided on the Sensor Control Panel.
Mosaic Mode Controls		
Enter Mosaic Sweep Parameters	The operator will enter the necessary input parameters to allow mosaic generation at the desired resolution. The system will provide assistance to ensure that the input parameters allow for mosaic generation (e.g. provides the operator with a recommended aircraft groundspeed to ensure 100% coverage).	• Touchscreen buttons are provided the Sensor Control Panel to assist the operator with optimizing the mosaic mode sweep parameters based on aircraft course, speed, and altitude.
Initiate Mosaic Mode	The operator initiates mosaic mode by selecting the Mosaic Mode function on the control panel. The operator monitors the moving map display to ensure the search is providing the desired coverage.	• Touchscreen buttons for initiating/terminating the Mosaic Mode function are provided on the Sensor Control Panel. • The AIMS primary display will also be reconfigured to increase the amount of real estate dedicated to presenting the stitched image.
Terminate Mosaic Mode	The operator terminates mosaic mode by de-selecting the Mosaic Mode function on the control panel. The operator verifies that the system status indicator is updated to reflect the manual steering	• Touchscreen buttons for initiating/terminating the Mosaic Mode function are provided on the Sensor Control Panel.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	mode, and the camera angle no longer changes automatically. The operator also verifies that the Pan and Tilt functions are available and functional.	
Resume Mosaic Mode	**The operator resumes the mosaic mode. The system will continue to ensure there is no loss of coverage.**	• Touchscreen buttons for resuming the Mosaic Mode function are provided on the Sensor Control Panel.
Monitor and Management Tasks		
Detect Platform Drift	The operator detects that the platform is drifting in one or more dimensions. An assessment is made as to whether the drift will impact the mission. The operator also makes a decision as to whether to eliminate the drift from the system.	• Requires further investigation
Null Platform Drift	Having detected that the platform is drifting from its commanded position, the operator attempts to eliminate the drift by activating the Null Drift function on the control panel. The operator monitors the platform re-alignment process, and verifies that the drift is eliminated from the system. The operator may also perform this task during system initialization prior to flight.	• Requires further investigation
Monitor Status of AIMS Display	The operator visually monitors the status of the AIMS display to ensure maximum effectiveness in accomplishing mission objectives. This task, which is conducted periodically throughout the mission, consists of evaluating the quality of display characteristics such as brightness, contrast, focus and colour. The operator makes a decision as to whether action is required to improve any of the display attributes.	• To assess the impact of changing settings, incoming imagery is presented within the operator's primary field of view.
Monitor Status of Laser Illuminator	The operator monitors the status of the Laser Illuminator for situational awareness and to ensure proper operation. This task involves verifying that the laser is armed or de-armed as appropriate, active or passive as appropriate, and that there are no system malfunctions indicated such as an over-temperature situation. In addition, the operator will monitor the "eye safety range" to ensure that the illuminator is not presenting a hazard to	• A readout of laser illuminstor settings is provided in the sensor window status region and on the sensor status tab of the primary AIMS display. • Primary laser illuminator settings are also continuously displayed in the top left corner of the primary AIMS display (Alert and

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	individuals on the ground. This task is performed periodically by the operator during all missions in which the AIMS system is in use.	System Status region).
Monitor Status of Video Recorder	The operator periodically checks the status of the video recorder to ensure it is functioning properly and there is adequate tape remaining. If the tape is running low, the operator makes a mental note that the tape will need to be changed at some time in the near future. A warning may be presented to the operator when the time remaining on the tape is extremely low.	• Primary video recording settings are also continuously displayed in the top left corner of the primary AIMS display (Alert and System Status region).
Replace Tape in the Video Recorder	The operator retrieves a new video tape and ensures it is annotated with the start time as required for the current mission. The tape in the recorder is removed and replaced with the new one. The removed tape is annotated with the stop time and other mission information as required. It is then stowed in a secure facility for the transit and landing phase of the mission.	• Does not impose requirements on the AIMS OMI design
Adjust Display Characteristics	The operator adjusts one or more of the display controls to enhance the usability of the information presented on it. During the performance of this task, which usually involves adjustments to the brightness and contrast controls, the operator monitors the display to achieve the best possible performance.	• Rotary knobs for continuous adjustment of the display brightness and contrast are provided on the bezel of each display. • To assess the impact of changing settings, incoming imagery is presented within the operator's primary field of view.
Adjust System Maintenance Controls	The operator makes minor adjustments to one or more maintenance control functions to optimize the performance of the AIMS system for increased mission effectiveness. This task, which is normally performed by maintenance personnel prior to flight, is rarely required to be performed by the operator during a mission. The task involves making minor adjustments to one or more maintenance control functions such as pre-set gain, brightness and contrast settings, auto-level settings (thresholds), default options, etc. The operator visually monitors the quality of imagery and alphanumeric data presented on the display during the performance of this task.	• Maintenance-related controls are provided on the Maintenance tab. Further investigation is required to fully define the required controls to make minor adjustments to maintenance functions.
Pre-search Tasks		

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
Discuss Weather Predicted for Area	The operator solicits information from other crew members on the weather conditions that are anticipated for the On Task area. The operator is likely to make brief written notes for future reference in planning the utilization of the AIMS sensor system. This task, which is required to augment information available in the mission briefing package, is particularly critical if the AIMS operator did not have the opportunity to attend the pre-flight weather briefing.	• Does not impose requirements on the AIMS OMI design
Review Known Features of Search Object	The operator solicits information to determine the characteristics of the search object that are likely to be significant to the search. The operator also refers to sensor performance data to assist in identifying characteristics that are particularly critical to the search. The operator may make brief written notes for future reference during both the planning and conduct of the search.	• Does not impose requirements on the AIMS OMI design
Review Terrain in Search Area	The operator reviews a geographical map of the search area to determine the type of terrain that can be expected.	• Does not impose requirements on the AIMS OMI design
Evaluate Expected Sensor Performance in Area	The operator evaluates the expected performance of the AIMS sensor system in relation to mission objectives. The operator considers all relevant factors including: nature of the mission, characteristics of the search object, type of terrain in the area, local weather conditions, the flight profile (i.e. altitude and speed), and equipment serviceability. A decision is made on the detection range and reliability that can be expected for the sensor.	• Does not impose requirements on the AIMS OMI design
Report Expected Sensor Performance	The operator briefs other crew members on the performance that can be expected from the AIMS sensor system. This report includes anticipated detection range for the object of the search, plus any other information that is relevant (e.g. equipment serviceability aspects, performance degradation due to weather, etc.). This report may be based on either observed or predicted performance.	• Does not impose requirements on the AIMS OMI design
Develop Initial Search Plan	Having determined the expected performance of the AIMS and other sensor systems, the operator develops the initial search plan. This plan emphasizes the utilization of the sensor system (or systems) that offer the best chance of accomplishing the mission. The plan defines all aspects of the search including the start point,	• Does not impose requirements on the AIMS OMI design

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	direction of search, track spacing, flight profile (altitude and speed) and sensors to be utilized. Selection of the primary sensor(s) may involve support by the system whereby the operator enters in the mission parameters and the system reports the 'optimum' sensor and configuration for the search.	
Determine Subsequent Search Plan	The operator considers the relative merits of alternative search methods, and determines an alternative search plan to be implemented in the event the initial plan does not achieve desired results. The plan defines all aspects of the search including the start point, direction of search, track spacing, flight profile (altitude and speed) and sensors to be utilized.	• Does not impose requirements on the AIMS OMI design
Report AIMS System Serviceability	The operator briefs other crew members on the serviceability of the AIMS system. This briefing includes an assessment of the impact of any unserviceabilities on the likelihood of being able to accomplish mission objectives.	• Maintenance-related information is provided on the Maintenance tab. Further investigation is required to fully define the required maintenance-related information to be displayed.
Update System Parameters for Search	In consideration of the search plan to be implemented, the operator accesses the System Status Information, evaluates the appropriateness of each setting, and adjusts any that are not appropriate for the search phase. The decision to change parameter settings is based primarily on the environmental conditions in the area, and a re-assessment of the likelihood that the search object will be cooperative. The operator verifies visually that all changes are updated in the system.	• Rotary knobs, toggle switches, and touchscreen buttons for adjustment of the sensor settings are provided on the Sensor Control Panel.
Conduct Pre-Search Briefing	A pre-search briefing involving all crew members is conducted on the aircraft intercom system. The Aircraft Captain initiates the briefing, and ensures the objectives of the mission are fully understood by everyone. Other operators brief individual aspects of the mission as required. Equipment unserviceabilities will also be reviewed at this time. The AIMS operator refers to a map of the area as required for situational awareness during the conduct of the briefing. The operator may also make written notes for reference throughout the mission.	• Does not impose requirements on the AIMS OMI design
Configure Moving Map Display	Prior to the conducting the search, the operator will configure the	• Touchscreen controls for configuring the moving map are

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	moving map to best meet the operational requirements. This includes selecting and configuring overlays to be displayed (e.g. known crash sites, sensor coverage) and choosing map orientation, scale, zoom, data format etc. The operator may re-configure these settings during the mission to better suit the search conditions.	provided on the Moving Map display.
Search Tasks		
Receive Report of Actual Weather Conditions from Flight Deck Crew	The operator receives a verbal report from the flight deck crew on the actual weather conditions in the vicinity of the aircraft. This report includes information such as ceiling, visibility, type and extent of cloud cover, precipitation (if any), winds at altitude, and prevailing light conditions (particularly during dawn and dusk times).	• Does not impose requirements on the AIMS OMI design
Observe Local Weather Conditions on AIMS Display	The operator visually inspects the video imagery to assist in determining actual weather conditions in the area. The operator also makes an assessment of the impact the weather is having on the quality of the imagery and overall sensor performance. The operator makes a decision as to whether any revisions are required in the tactics planned for the mission. The operator may also perform this task in situations when the AIMS is not being used as a primary search sensor (e.g. to augment a visual search).	• To assess the actual weather conditions in the area, incoming imagery is presented within the operator's primary field of view.
Compare Actual and Forecast Weather Conditions	Having determined actual weather conditions in the area, the operator compares the actual conditions with the original forecast for the area. A decision is made as to whether the actual conditions are sufficiently different to require a re-evaluation of sensor performance. The operator is likely to refer to the weather briefing package and consider discussions with other crew members during the performance of this task.	• Does not impose requirements on the AIMS OMI design
Determine Actual Sensor Performance in Area	The operator re-evaluates sensor performance based on conditions actually observed in the area. This involves evaluating the likely impact of the environmental and terrain conditions that differ from the predictions, and making an assessment as to whether sensor performance is likely to be better or worse than predicted. The operator also checks the performance by observing the quality of the video imagery and determining actual detection ranges for	• To assess the sensor performance, incoming imagery is presented within the operator's primary field of view. • Rotary knobs, toggle switches, and touchscreen buttons for adjustment of the sensor settings are provided on the Sensor Control Panel.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	objects similar to the subject of the search. The operator makes a decision as to whether mission tactics must be adjusted because of actual sensor performance.	
Monitor AIMS Display for Search Object	The operator visually scans the video imagery in an attempt to identify the object of the search. The operator may refer occasionally to Standard Operating Procedures to assist in establishing a systematic search pattern to achieve maximum area coverage. This task may be conducted in conjunction with the Auto-Scan function or in a manual scan mode (by utilizing the Pan and Tilt functions).	• To visually scan the video imagery in an attempt to identify the object of the search, incoming imagery is presented within the operator's primary field of view.
Initiate/Deactivate Auto-cueing Function	The operator activates/deactivates the image processing algorithms to support the Auto-Cueing function.	• Requires further investigation
Maintain a Record of Sensor Coverage of Area	The operator maintains a record of the areas that have received sensor coverage as the search progresses. This is accomplished with map shading which is updated continuously (or at regular intervals) either manually or automatically. The operator refers to this information periodically to ensure the entire area is covered in the course of the mission. This information is also required during post-mission analysis to assist in planning subsequent missions.	• Overlays are presented on the Moving Map Display to illustrate a history trail of previously viewed ground terrain. Overlays are also provided for regions searched with reduced sensor effectiveness and ground areas masked by terrain.
Receive Report of Radar or Visual Contact	The operator receives a report of a contact that has been detected either visually or on radar. The report includes estimates of the type and position of the contact. The position information is reported as a range and bearing. The bearing may be reported using the standard clock system or in degrees relative to either True North or aircraft heading. The operator refers to the display for situational awareness during the performance of this task, and records the information manually for future reference.	• To assist with maintaining situational awareness, the Moving Map Display presents the aircraft with its current position and heading as well as the camera orientation and sensor coveragre. • A polar plot, adjacent to the incoming imagery presents the camera angle relative to True North and aircraft heading.
Slew Turret to Radar or Visual Contact	The operator slews the turret to the geographic position of a contact detected either visually or on radar. This is accomplished either by entering the range and bearing to the contact and initiating the Auto-Slew function, or by manually adjusting the Pan and Tilt control functions in response to the directions provided. The operator verifies that the camera angle and video imagery are updated as	• Future versions of the AIMS system could employ a tactical plot with radar contacts so that an operator can easily slew the system to these contacts for further investigation.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	expected.	
Set AIMS Auto-Scan Parameters	The operator selects the desired auto-scan pattern from a preset list. This activity is normally conducted prior to the commencement of the search, but may also be conducted at other times as required to improve the probability of detection. The operator may refer to Standard Operating Procedures during the performance of this task.	• Touchscreen buttons for initiating/terminating the Auto-Scan function are provided on the Sensor Control Panel. • Touchscreen buttons are also provided to assist the operator with optimizing the scan pattern based on aircraft course, speed, and altitude.
Re-Initiate Search at Previously-Designated Position	Having completed a contact investigation, the operator re-initiates the search for the object of the search at a previously designated position. This task is performed in conjunction with the pilot re-establishing the aircraft on the proper flight profile. The operator monitors the accuracy of the aircraft position, providing verbal guidance to the pilot as necessary. The operator verifies that the AIMS system is correctly configured for the search, and re-initiates scanning at the appropriate time (in either automatic or manual scanning mode).	• Requires further investigation
Detection Tasks		
Designate Targets	The operator while viewing imagery (mosaic or real-time) marks a potential target. The operator visually verifies that the moving map display is updated with an overlay. The operator may also enter a short text comment to accompany the designated target.	• The Designate Target button located on the hand controller will take a snapshot of the current search location and deposit a numbered contact marker on the moving map. • Contact files can be edited through the context-sensitive menu associated with the contact marker.
Capture Single Frame Imagery	The operator captures still frame images from the primary by activating the Capture function on the control panel.	• The Designate Target button located on the hand controller will take a snapshot of the current search location and deposit a numbered contact marker on the moving map. • Image capture and video imagery tab provides the ability to record AIMS images, create video clips, view snapshots, and e-mail both images and clips.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
Begin Recording AIMS Images	The operator initiates video recording by activating the Record function on the control panel. The recording will capture both the AIMS imagery as well as the associated meta data. The operator verifies that the video recorder status is updated and the tape counter begins counting as expected. Initiation of the video recording may also occur upon commencing the search.	• Image capture and video imagery tab provides the ability to record AIMS images, create video clips, view snapshots, and e-mail both images and clips. • Recording of AIMS images may be automatically initiated at the beginning of a mission.
Report Status of Video Recording	The operator advises the other crew members that video recording has been either initiated or terminated. If applicable, the reason for the change will also be briefed.	• Status of video recording is continually visible in the Alerts and System Status portion of the primary AIMS display.
Detect Contact on AIMS Display	While monitoring the AIMS display, the operator visually detects a contact with characteristics associated with the object of the search. The operator notes the relative position of the contact plus aircraft position, heading, altitude and speed at the time of the detection to assist in relocating the contact if necessary. The operator conducts a preliminary analysis of the contact and makes an assessment as to whether the contact warrants further attention (i.e. do not investigate further, investigate immediately, or investigate at some later time).	• Sensor windows on the primary display depict real-time incoming imagery from two sensors. • Relative contact position and aircraft-related data is provided as part of the Polar Plot on the main AIMS display.
Report AIMS Detection	The operator alerts the other crew members to the fact that a contact has been detected that may be the object of the search. This report includes an estimate of the approximate position of the contact (i.e. bearing and range, possibly with reference to the clock system), plus an indication of the likelihood that it is the object of the search. The operator continues to focus attention on the object to ensure it is not lost.	• Relative contact position and aircraft-related data is provided as part of the Polar Plot on the main AIMS display.
Initiate a Contact File	The operator initiates a contact file on the detected contact. This is accomplished by designating the contact on the video imagery. The contact is assigned a waypoint number, and the relative position information is transferred to the navigation system where a geographic position is calculated. The waypoint also appears on the moving map display annotated with the waypoint number. A screen capture image is stored for future reference. The operator may make handwritten notes about the contact on a notepad.	• The Designate Target button located on the hand controller will take a snapshot of the current search location and deposit a numbered contact marker on the moving map. • Contact files can be edited through the context-sensitive menu associated with the contact marker.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
Terminate Recording AIMS Images	The operator terminates video recording by de-selecting the Record function on the control panel. The operator verifies that the video recorder status is updated and the tape counter stops counting as expected.	• Recording of AIMS images may be automatically initiated at the beginning of a mission and terminated upon mission completion.
Tracking Tasks		
Track AIMS Contact Manually	Having detected a contact of interest, the operator tracks the contact manually with the AIMS system. This is accomplished by making continuous adjustments to the Pan and Tilt angles to maintain the approximate centre of the video FOV on the contact.	• The hand controller provides an omni-directional chinese hat for manual adjustment of the Pan and Tilt angles.
Adjust tracking mode parameters	The operator will adjust the tracking mode parameters to best suit the mission. This includes selecting edge or centre tracking, adjusting the window size, etc. These parameters are available for both tracking modes.	• Requires further investigation
Geo-Tracking (AUTO POINT) Mode Controls		
Initiate Geo-Tracking (AUTO POINT) mode	The operator initiates automatic tracking of the AIMS system by designating a particular geographic location (by entering a lat/long or clicking a point on the moving map) and activating the Auto-Track function on the control panel. The operator verifies that the system status information reflects the AUTO-POINT Mode, and that the centre of the video FOV remains centered on the designated geographic position.	• The Auto-Track switch located on the hand controller will toggle the primary sensor in and out of auto-tracking mode.
Terminate AUTO POINT mode	The operator terminates Auto-Point mode by de-selecting the Auto-Point function on the control panel.	• The Auto-Track switch located on the hand controller will toggle the primary sensor in and out of auto-tracking mode.
Auto Track Mode Controls		
Initiate AIMS Automatic Tracking	The operator initiates automatic tracking of the AIMS system by designating a particular contact and activating the Auto-Track	• The Auto-Track switch located on the hand controller will toggle the primary sensor in and out of auto-tracking mode.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	function on the control panel. The operator verifies that the system status information reflects the Auto-Track Mode, and that the centre of the video FOV remains centered on the designated contact of interest.	• Overlays on the sensor window will indicate when auto-tracking is active as well as denote the type of auto-tracking.
Adjust AIMS Automatic Tracking Manually	Having observed that the Automatic Tracking function has not maintained the position in the centre of the FOV, the operator manually adjusts the camera alignment to re-centre the image. This is accomplished using the Pan and Tilt functions while visually monitoring the display to achieve accurate positioning.	• The hand controller provides an omni-directional chinese hat for manual adjustment of the Pan and Tilt angles.
Report AIMS Automatic Tracking	The operator advises the other crew members that the contact of interest is being automatically tracked by the AIMS system.	• The contact of interest will remain centered within the primary sensor window.
Monitor the Accuracy of the Automatic Tracking Function	The operator periodically evaluates the accuracy of the automatic tracking function by observing the relative location of the contact or position of interest within the camera FOV. The operator makes a decision as to whether there is a need to make a manual adjustment to the tracking function.	• Does not impose requirements to AIMS OMI design.
Advise Pilot of the Status of the AIMS Tracking Function	The operator verbally advises the pilot of the status of the AIMS function. The information exchanged typically includes whether the system is in automatic or manual tracking mode. The operator also advises the pilot of the accuracy of the tracking system.	• Overlays on the sensor window will indicate when auto-tracking is active as well as denote the type of auto-tracking.
Classification and Identification Tasks		
Monitor Contact on AIMS Display	The operator visually monitors the contact on the AIMS display. The purpose of this task is to ensure that contact is not lost, and to possibly obtain additional information on the contact as it is viewed from a different perspective.	• To visually monitor a contact, incoming imagery is presented in sensor windows which are located within the operator's primary field of view.
Identify AIMS Contact	The operator analyzes the imagery to determine whether the contact is the subject of the search. During the performance of this task, the operator uses the zoom function extensively, and adjusts other system parameters to increase the probability of identification.	• Controls for adjusting system parameters are readily accessible from the Sensor Control Panel.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	The operator may replay the video recording to be able to view the image in slow time. For difficult contacts, the operator considers ways to increase the likelihood of a positive identification.	
Report Contact Identification	The operator advises the other crew members of the identity of the contact of interest or, alternatively, indicates that an identification is not possible. If applicable, the report also includes an assessment of the degree of certainty of the identity of the contact. If the contact could not be identified, the report may also include recommendations on how a positive identification may be achieved.	• Does not impose requirements to AIMS OMI design.
Determine Range and Bearing to Contact	The operator determines the range and bearing from the aircraft to the target from the display of camera angle and range. The operator has the option of obtaining the bearing relative to either True North or aircraft heading.	• Contact range and bearing from aircraft aw well as aircraft-related data is provided as part of the Polar Plot on the main AIMS display.
Report Range and Bearing to Contact	The operator advises the other crew members of the range and bearing from the aircraft to the contact of interest. The information must be passed in a format that is readily usable by the recipients. The bearing may be passed relative to either True North or aircraft heading.	• Contact range and bearing from aircraft aw well as aircraft-related data is provided as part of the Polar Plot on the main AIMS display.
Monitor Estimated Range to Contact	The operator monitors the estimated range to the target for situational awareness and to ensure optimal functioning of the AIMS. Since the system does not possess a laser rangefinder, the range is determined through calculations.	• Contact range and bearing from aircraft aw well as aircraft-related data is provided as part of the Polar Plot on the main AIMS display.
Mark Index on Recording	The operator inserts a reference mark on the video recording to mark a point of interest for airborne or post-mission analysis replay. This is accomplished by activating the Recorder Index function on the control panel. The operator makes a voice annotation on the tape to indicate the reason for the index. The operator makes a mental note of the number of the reference mark to facilitate locating the contact on the tape if required.	• Image capture and video imagery tab provides the ability to record AIMS images, create video clips, as well as view and e-mail both snapshots and video clips.
Playback Video Imagery	Having determined a need to re-evaluate video imagery, the operator stops the recording and rewinds the tape to the desired position. This is accomplished by activating the Tape Rewind	• Image capture and video imagery tab provides the ability to record AIMS images, create video clips, as well as view and e-mail both snapshots and video clips.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	function on the control panel, and inserting the applicable Tape Index number. The Tape Replay function is then activated, the operator verifies that the tape has been rewound to the correct position, and then monitors the taped video as necessary. The operator verifies that the system status information reflects the tape replay status. The operator also has the option to adjust the contrast while in the replay mode.	mail both snapshots and video clips.
Review Still Frame Imagery	Having determined a need to re-evaluate still frame imagery, the operator selects the desired image(s).	• Image capture and video imagery tab provides the ability to record AIMS images, create video clips, as well as view and e-mail both snapshots and video clips.
Decide if the Detected Contact is the Object of the Search	The operator considers all information available on the detected contact and makes a decision as to whether it is likely to be the object of the search. The decision is based on a comparison of the information available on both the detected contact and the object of the search (i.e. contact position, last known position of the object of the search, results from the classification/identification of the contact, etc.).	• Does not impose requirements to AIMS OMI design.
Report if Contact is (or is not) the Search Object	The operator briefs the other crew members on whether the detected object is likely to be the subject of the search. Depending on the accuracy of the classification/ identification process, the report is likely to address three options: the contact is likely the object of the search and rescue procedures should be initiated; the contact may be the object of the search and further attempts to classify/identify it should be initiated; or the contact is unlikely to be the object of the search and the search should be resumed. The report includes a brief summary of the reasons for the decision, plus an assessment of the reliability of the information.	• Does not impose requirements to AIMS OMI design.
Annotate Sensor Contact File	The operator annotates a handwritten contact file with new information as it becomes available.	• Image capture and video imagery tab provides the ability to include additional information with a given snapshot or video clip
Evaluate Area Coverage	The operator visually inspects the moving map of the area and evaluates the extent of the area that has been adequately searched. This task is facilitated by the fact that the operator has maintained a continuous record of the areas that have been searched throughout	• Digital moving map is located on the primary display within the operator's primary field of view. A larger digital moving map is allocated to another display.

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	the mission. The operator makes an estimate as to whether the search of the assigned area can be completed during the On Task period.	• Overlays provide a record of the areas that have been searched as well as areas that may need to be revisited due to inclement weather
Terminate Video Playback	The operator terminates video playback by de-selecting the Playback function on the control panel. The tape is rewound to the end of the previously recorded portion of the tape in preparation for re-initiating tape recording. The operator verifies that the system status information is updated to reflect the fact that video replay has been terminated.	• Recording of AIMS images may be automatically initiated at the beginning of a mission and terminated upon mission completion.
Rescue Site Evaluation		
Determine Nature of Local Terrain on AIMS Display	The operator inspects the video display to determine the nature of the local terrain to conduct rescue operations. The operator uses the camera control functions (e.g. Pan, Tilt, Zoom, etc.) to assist in the performance of this task. The operator pays particular attention to the nature of the ground cover, the location and height of obstacles in the area, the slope of the terrain, and the proximity of open areas that could facilitate dropping equipment. This task is conducted concurrently with similar assessments by other crewmembers.	• Sensor windows on the primary display depict real-time incoming imagery from two sensors • Camera control functions are located on both the hand controller and Sensor Control Panel.
Assess Hazards in Area	The operator mentally determines if the terrain features pose any hazards that are likely to impact subsequent SAR Tech operations. A decision is made as to whether there are any aspects of the terrain that warrant particular consideration.	• Does not impose requirements to AIMS OMI design.
Maintain Situational Awareness Using Displays	The operator monitors the display to maintain continuous situational awareness with respect to the mission in progress. The operator focuses on the following aspects of the mission: own aircraft position, altitude, speed and heading; relative positioning of the search area and detected contacts; terrain elevation and features; local weather conditions.	• Digital moving map with overlays illustrates the current position of the aircraft and its sensor, search history, contact markers, terrain features, etc. • Helps operator to maintain SA in support of missions
Report Terrain Features	The operator briefs the other crew members on the significant features of the terrain in the vicinity of the contact of interest. The	• Does not impose requirements to AIMS OMI design effort

TASK	TASK DESCRIPTION	IMPLEMENTATION WITHIN AIMS OMI
	briefing includes information on the suitability of the terrain for insertion of SAR Techs to the rescue site.	
Return Transit Tasks		
Receive Direction to Conduct Off Task Checks	The operator receives direction from another crew member to conduct the Off Task checks.	• Does not impose requirements to AIMS OMI design effort
Unload AIMS Recorder	The operator removes the video tape from the recorder and annotates it with mission information as required. It is then stowed in a secure facility for the transit and landing phase of the mission.	• Does not impose requirements to AIMS OMI design effort

List of symbols/abbreviations/acronyms/initialisms

AC	Alternating Current
AGL	Above Ground Level
AGTV	Active Gated Television
AIMS	Advanced Integrated Multi-sensor Surveillance
ALBEDOS	Airborne Laser Based Enhanced Detection and Observation System
ASL	Above Sea Level
CCD	Charge Coupled Device
CFB	Canadian Forces Base
DC	Direct Current
ELT	Electronic Locator Transmitter
ELVISS	Enhanced Low-Light Level Visible and InfraRed Surveillance System
EO	Electro Optic
ESM	Electronic Support Measures
FO	First Officer
FOV	Field of View
FWSAR	Fixed Wing Search and Rescue
HF	High Frequency
HFE	Human Factors Engineering
IR	Infrared
JRCC	Joint Rescue Co-ordination Centre

KIAS	Knots Indicated Airspeed
LF	Land Forces
LLLTV	Low-Light Level Television
MP&EU	Maritime Proving and Evaluation Unit
NASO	Non Acoustic Sensor Operator
NFOV	Narrow Field of View
NOHD	Nominal Ocular Hazard Distance
NUC	Non-Uniformity Check
OMI	Operator Machine Interface
SA	Situational Awareness
SAR	Search and Rescue
SARPAL	SAR Palletized
SENSO	Sensor Operator
SME	Subject Matter Expert
SOI	Statement of Operating Intent
SOR	Statement of Operational Requirements
TACAN	Tactical Air Navigation
TAS	True Air Speed
TDP	Technology Demonstration Program
UCD	User-Centered Design
VFR	Visual Flight Rules
VHF	Very High Frequency
VOR	VHF Omni Range
WFOV	Wide Field of View

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(U) To enhance the capability of airborne search and rescue (SAR) and surveillance, particularly at night and in poor weather, a multi–sensor electro–optical imaging system, the Advanced Integrated Multi–sensor Surveillance (AIMS) system, is being developed by Defence Research & Development Canada. The AIMS system is advanced through active gated capability and the integration of five sensors into a single gimbal. As such, the system will support a myriad of missions for both the CP–140 and FWSAR communities including timely SAR response and ground surveillance in aid of the Land Forces (LF). To ensure optimal performance the AIMS system requires an appropriate interface and controls, the design of which must realize the interaction between technological capability and operator performance. This document, prepared by CAE Professional Services on behalf of Defence Research and Establishment Canada, presents preliminary design concepts and associated rationale for the AIMS Operator Machine Interface (OMI). The intent is to provide a framework for the future evolution of the AIMS OMI as well as identify areas for investigation.

(U) Afin d’augmenter la capacité de recherche, de détection, de classification et d’identification de contacts, en particulier la nuit et par mauvais temps, un système intégré perfectionné de surveillance multi–capteurs (AIMS) est en cours de développement. Ce système est perfectionné par l’intégration de cinq capteurs à capacité de déclenchement actif en un cardan unique. Il pourra ainsi servir à une multitude de missions de CP–140 et de FWSAR (aéronefs à voilure fixe pour la recherche et sauvetage), entre autres pour des interventions rapides de recherche et de sauvetage et la surveillance au sol à l’appui des forces terrestres (FT). L’efficacité optimale du système AIMS nécessite une interface et des commandes appropriées, dont la conception doit assurer l’interaction entre la capacité technologique et les performances des opérateurs. Le présent document, rédigé par CAE Professional Services pour RDDC Canada, présente les principes de conception préliminaires de l’interface opérateur–machine (IOM) et les justifications connexes. Il vise à fournir un cadre pour l’évolution future de l’IOM du système AIMS et à identifier des domaines d’étude.

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(U) search and rescue, maritime patrol, human–machine interface, optical imaging, sensor, surveillance

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